

*A webcomic of romance, sarcasm,
math, and language*

xkcd

RANDALL MUNROE

2023

xkcd

2023

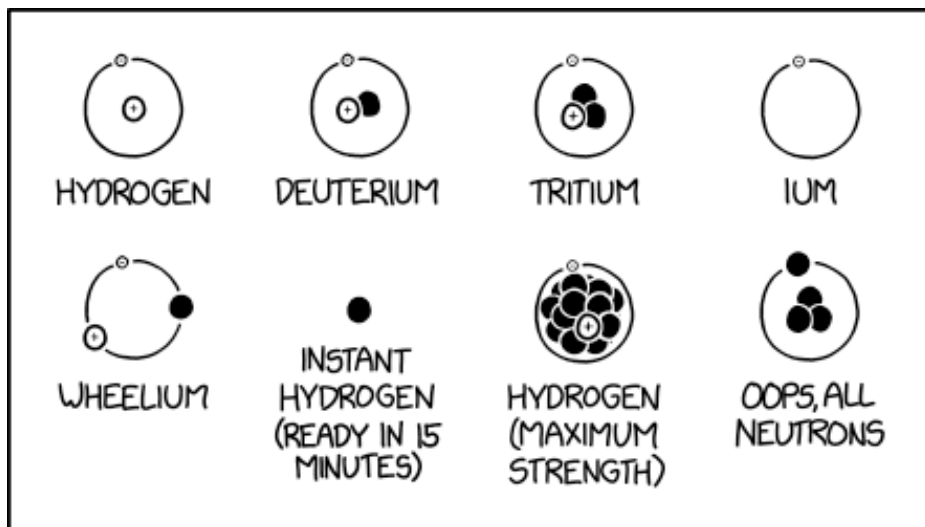
a collection of 156 webcomics

from #2719 to #2874

by Randall Munroe

#2719: Hydrogen Isotopes

January 02, 2023



Oops, All Neutrons is also known as Neutral Quadrium, Nydnonen, and Goth Tritium.

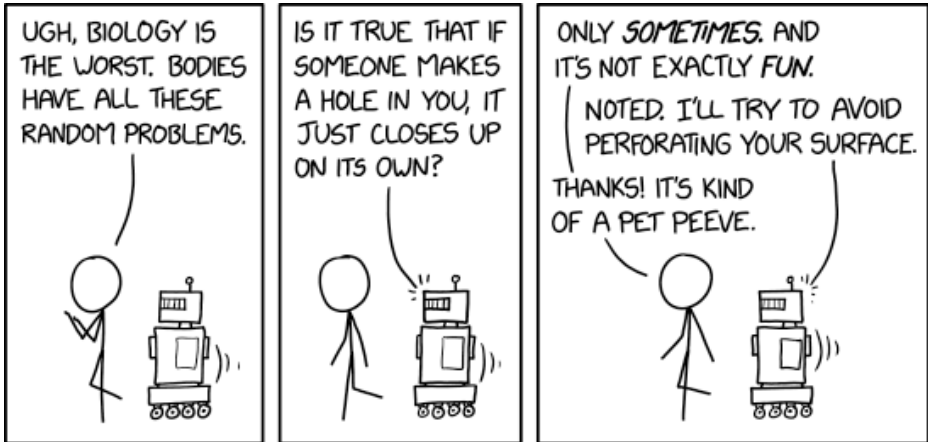
Explanation

Hydrogen is the simplest of the chemical atoms, usually consisting of an electron orbiting a lone proton, but it has two other naturally occurring isotopes. This comic shows real and humorously fictional forms of hydrogen, generally depicted according to the Chadwick model of the atom; see 2100: Models of the Atom for details.

The title text provides three other names for Oops, All Neutrons:

#2720: Biology vs Robotics

January 04, 2023



Sorry, I've just always had these random things I don't like--like olives, or robots drilling holes in me without warning.

Explanation

In this comic, Cueball is walking along next to a robot holding a conversation – from this we can infer the robot is sentient or even sapient. Cueball is complaining to said robot about the problems of biology, especially his own biology, whining that "biology is the worst" and "bodies have all these random problems". The human body does have many challenges, ranging from the mildly inefficient to the lethal-without-warning, and culminating in irreversible senescence and obligate mortality. The robot, an abiological entity (some exceptions apply) responds by posing a question which may or may not be intended as rhetorical.

The robot thus highlights an advantage that biological bodies have – i.e., the ability to heal themselves, while metal robots like this one don't and probably must seek out repairs. However, Cueball immediately points out that this ability only works "sometimes", and is often painful. First and foremost, one must actually survive a hole if they wish to heal from it, as death comes with some pretty big impacts on their continuing ability to do so.[citation needed] Secondly holes can come in all sorts of shapes and sizes, in many widths and depths with many further complications (including the aforementioned death). For example, a small hole made for an earring would be easy to close, whereas one carved by a 91.4cm mortar shell would be less easy to heal.[citation needed] There is also ambiguity in what counts as a hole. Is a cut a hole? Is surgery, etc? This

variability is likely why Cueball says "Sometimes".

He also states that "it" is "not exactly fun". This is either sarcasm or an understatement, as some holes can really hurt. "It" is implied to be the holes themselves, as while the healing process can hurt, the formation of the hole (such as being shot) is often a lot more painful.[citation needed]

The title text is Cueball apologizing for his whining, explaining his frustration with certain things such as particular fruits and unexpected robotic incursions. He appears to equate these two issues, where most normal people would consider one a minor irritation, and the other a serious threat (though he may be deliberately making this comparison sardonically). Even when a robot is used purposefully for cutting into a human (such as robotic surgery), it should be expected and consented to. There are few situations where cutting open a human without consent would be considered socially, morally, legally or cybernetically acceptable in most countries [citation needed] (one example would be a trained medic trying to saving an unconscious person's life by urgently cutting into them in some way).

Part of the humor may also derive from the fact that Cueball is complaining about things which the Robot could only dream of for its own future (self-repair, automatic recharging from abundant naturally occurring proteins [food], self-replication without external construction, etc). This is similar to 1839: Doctor Visit where the doctor marvels at the fact that "your body has

been moving around for years and still works at all. My USB cables fray after like a month". Some people argue [citation needed] that self-replicating, self-repairing sentient robotics would in their complexity be quite similar to biological systems and might even suffer from similar problems.

#2721: Euler Diagrams

January 06, 2023



Things Leonhard Euler created (most of math (overlapping circle diagrams) a cricket bowling machine)
Things John Venn created

Explanation

In this comic, Cueball is showing a diagram titled "Venn diagram" he made about something to an unseen audience. An off-panel person informs Cueball that it is an Euler diagram, and starts to explain why, prompting Cueball to forestall the interruption and state that many things are named for Leonhard Euler (specifically Euler's constant and Euler's function apart from Euler diagram) and he just wants to call the diagram a Venn diagram to give John Venn a more equal share of the fame. His off-screen friend refuses, and mockingly states that numbers are now called "Euler letters".

This may be in response to the fact that Randall has made several comics about both Euler diagrams and Venn diagrams and has sometimes used the term Venn diagram for an Euler diagram, as in 2090: Feathered Dinosaur Venn Diagram. Maybe this was on purpose, as Cueball did here, or by mistake. In either case Randall has probably heard a lot from fans and friends when he made these comics, and thus this could be seen as a response.

A Venn diagram is a widely used diagram style that shows the logical relation between sets. It shows overlap of items in different categories (sets) by using overlapping circles (or other shapes) to stand in for categories. If an item is within a certain circle, it is in the category the circle represents. So in a Venn diagram of "animals" and "furry things", "cat" would be in the overlap between

both circles, "frog" would be inside only "animals", and "kiwifruit" would only be in "furry things". "Crystals" would be outside both circles.

John Venn was not the first to invent the idea of drawing regions whose overlap shows the intersection of sets — that was popularized by Euler (although he may not have been the first to do it) and was known as Euler Diagrams. Venn's innovation, roughly 100 years later, was to consistently draw ALL intersections of sets, even those intersections that had no members. In a Venn diagram, all 'circles' must overlap with all other circles, even if there are no items in the overlap. This is easy enough for 2 and 3 sets, but as the number of sets increases, the diagrams can get rather complicated, as previously shown in 2122: Size Venn Diagram. These three links demonstrate the issue, in which sets can start looking very non-circular. An Euler diagram is required to depict only the non-empty combinations/sets, and therefore does not have this constraint. The diagram in the comic does not have any overlap between the left and right sections so, while it is an Euler diagram, it is not a Venn diagram.

The title text is an example of a "written" Venn diagram, with Leonhard Euler creating "most of math", both of them having created overlapping circle diagrams, and John Venn creating a cricket bowling machine. In his Wikipedia article it is stated that With his son, Venn developed a bowling machine that was able to impart

spin to a cricket ball. When members of the Australian cricket team visited Cambridge in June 1909, Venn's machine bowled Victor Trumper, one of their star batsmen. See the title text drawn as a diagram in the inserted picture.

On a side note, if Euler letters were a thing, then they would be digits. And numbers would be Euler words!

#2722: Etymonline

January 09, 2023

etymonline (n) et·y·mon·line /,et.əmon'lain/
The history and derivation of a word. Altered form of English *etymology*, from Old French *ethimologie*, from Latin *etymologia*. Quotation: "Before it came to refer to Jupiter's sky-cities, the term 'blimp' was used for 20th century Earth airships, but its etymonline before that is unknown." —*Jovian Blimps: A History* (2384)

IRONICALLY, THE POPULARITY OF ETYMONLINE EVENTUALLY CAUSED THE LOSS OF THE WORD "ETYMOLOGY" FROM ENGLISH.

NOTE TO FUTURE ETYMONLINGUISTS: Our best guess is that 'blimp' is onomatopoeia. The 'B-Limp' thing is a folk etymology.

Explanation

This comic depicts an entry from a dictionary written in the far future (at least the year 2384 based on the textual reference). The entry gives the definition of the word "etymonline" and makes it clear that this word has simply supplanted the word "etymology" in the intervening centuries.

It references the internet service known as Etymonline, or the Online Etymology Dictionary, and implies that Etymonline as a source became synonymous with the concept of etymology.

The caption to the comic states that it is ironic that the popularity of Etymonline eventually caused the loss of the word "etymology" from English. Perhaps Etymonline grew into such a comprehensive and reputable source that it deserved the all-encompassing identification with the concept of etymology (through metonymy); or it simply gained such ubiquity and market dominance that it became, to all intents and purposes, the only service people used to meet their etymological needs and popular usage abandoned the original term in favor of the name for the tool associated with learning a word's origin. All we know is that the brief etymology given in the entry cites "modification" of a more archaic English form (the one we are familiar with), without any mention of the digital resource. This is a mild failure on the part of the dictionary entry, since the suffix "online" should at least have been noted as the modifier resulting

in the current form. Perhaps a discussion of the specific internet service was not relevant in the entry, or the very concept of "online" has been so superseded by whatever its successors or usurpers might have become that it was lost to common, or indeed academic, knowledge.

The entry about etymonline uses, as an example of the use of the word, a quote regarding the etymology (etymonline) for the word Blimp. This example is a quote from a book from the year 2384 called Jovian Blimps: a History, dating the definition entry as being from some time after that work was published. It also states that, by that year, the word blimp no longer refers to a kind of airship still used on Earth (at the actual time of this comic's release) but instead to "Sky-cities" floating in the atmosphere of Jupiter. Although it is still known that Blimp was once used for Earth airships, while presuming that the reader is overwhelmingly aware of the Jovian examples.

The title text plays with this (replacing "etymologist" with the derived term "etymonlinguist"). Following on from the fictional citation's assertion that the origin for those historic airships being called Blimps is unknown, we get a comment from some present-day scholar (directed to the author of the futuristic entry) clarifying what they know about the etymology of the word "blimp". It references two theories of the etymology: that it is simply onomatopoeia; or that it was constructed from the phrase "Type B - Limp". It rejects the latter as a folk etymology, i.e. a back-formation, consistent with the explanation on Wiktionary and the Etymology section

on the Blimp article upon Wikipedia. It is interesting to note that the current Etymonline entry only lists the B-Limp origin and does not mention onomatopoeia at all, though it does at least acknowledge that the origin is "obscure".

Already, a day after the release of this comic, the words mentioned in here trended on Etymonline, see more in the trivia section below.

#2723: Outdated Periodic Table

January 11, 2023

FIGURE 6.14

THE PERIODIC TABLE OF THE ELEMENTS

H HYDROGEN		He HELIUM
Li LITHIUM	Be BERYLLIUM	

YOU CAN SPOT AN OUTDATED SCIENCE TEXTBOOK BY CHECKING THE BOTTOM OF THE PERIODIC TABLE FOR MISSING ELEMENTS. FOR EXAMPLE, MINE WAS PUBLISHED HALF AN HOUR AFTER THE BIG BANG.

Researchers claim to have synthesized six additional elements in the second row, temporarily named 'pentium' through 'unnilium'.

Explanation

This comic shows figure 6.14 from a science text book, which displays The periodic table of the elements, but with only the first four elements (hydrogen, helium, lithium and beryllium) shown. Randall claims in the caption that you can use such charts to date a publication based upon the elements present or missing. While this is true in a sense - for example, Nihonium, Moscovium, Tennessine and Oganesson were first discovered in 2003 and named in 2016, thus charts made before 2016 would have the systematic element names Ununtrium, Ununpentium, Ununseptium and Ununoctium and completely absent before 2003 - Randall injects humor by taking it to the extreme and showcasing a periodic table from a book published just half an hour after the Big Bang, at which time those four elements were the only ones present.

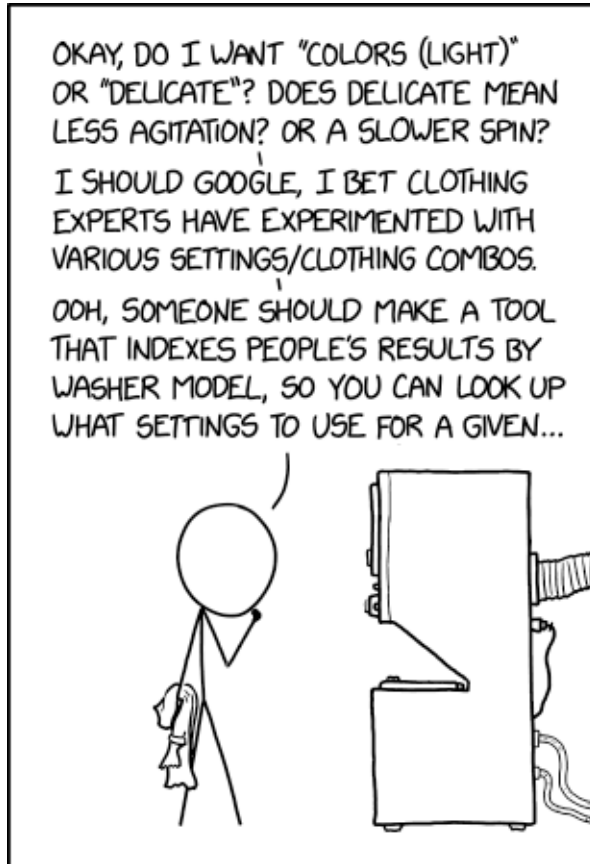
From about 10 seconds until about 20 minutes after the Big Bang, the phase that is known as the Big Bang nucleosynthesis occurred. At that time, hydrogen ions (single protons) provided for helium in abundance and traces of lithium. Some beryllium-7 was also formed, which is an unstable isotope having a half life of 53 days. Randall's science book was published when those four elements were the only ones in existence, even though this would be absurd since no life as we know it could exist with only these four elements to write and publish the book; perhaps it is why Randall's mysterious textbook seems and manages to reflect the direct state of

elements existing in nature, even though the real life periodic table was slowly filled out based on what could be easily found and later synthesized. For example, despite helium being one of the first elements to exist, and still one of the most common in the universe (roughly 24%, by mass, with hydrogen being around 75% and every other element combined being the remainder), it did not appear in the earliest periodic tables.

The title text refers to how yet-undiscovered elements are given a systematic element name as a temporary name, until a more permanent name is decided upon. The names are based upon a standard group of Greek and Latin roots that read out the decimal digits of an element's unique atomic number (i.e., the number of protons) and adding "-ium" to the end. The claim in the title text is that, in the textbook with the figure, researchers claim they have synthesized six additional elements in the second row, temporarily named 'pentium' (atomic number "5") through to 'unnilium' ("one zero", or "10"). In reality, all these elements are well known as Boron, Carbon, Nitrogen, Oxygen, Fluorine and Neon. The word "Pentium" is also the brand name of some computer hardware which may contain some amount of boron.

#2724: Washing Machine Settings

January 13, 2023



EVERY NOW AND THEN I FORGET
THAT PRODUCT MANUALS EXIST AND
SPEND A WHILE REINVENTING THEM.

I guess the engineers who built my dishwasher **MIGHT** have some insight into how to load it, but instead of reading the booklet they gave me, it seems easier to experiment for years and then get in arguments so heated that I get

banned from Quora.

Explanation

The comic strip depicts Cueball (possibly Randall) standing in front of a washing machine, wondering which settings to use for his particular wash load. He ponders as to the intended meaning behind the word "Delicate" and decides to look up detailed information on what the settings do and when to use them. A thought then occurs to him that there should be a location where people could crowd-source data on what settings they have found work best for various clothing items, before realizing that that would likely have already been done by the manufacturers beforehand and the results put into the product manual.

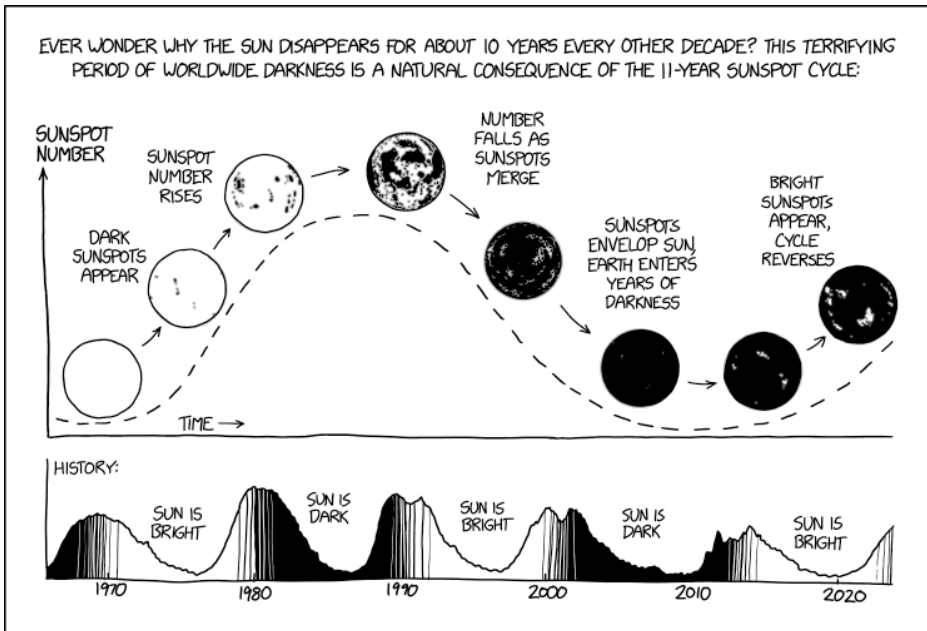
Labels on appliances tend to be terse, often using single words that make the intended interpretation challenging. In this case Cueball likely is trying to wash something that is both "delicate" and has "colors", but is forced to choose between them, even though there would ideally be a washer setting that anticipates the need for both considerations at once. Due to the laconic vagueness in the choice of wording for the dial (or button/menu), the "(Light)" may refer to the setting being intended for lightly or pastel colored clothing, that the setting is meant for delicate fabric, or that it is a quick, surface-level wash (i.e. as opposed to deep cleaning), though a separate "half load"/"economy" button (or similar) often exists that abbreviates the appropriate phases of each main washing cycle accordingly.

The title text proposes deliberately ignoring the manual for a dishwasher and continuing to use the internet and other people for information on household devices. This might refer to the tendency for people to not read manuals and instead post their queries online awaiting answers, which sometimes gets disparaging comments to read the manual. It also references Quora, a website which allows users to publicly ask questions and answer the questions of others. The website is not typically known for its debates, although the situation in this comic could probably lead to one, as it is quite opinion-dependent with no true correct answer (even the suggested settings given in the manual, written by the makers themselves, could be prone to disagreement as users might find the settings to have adverse effects on their clothing, or discover an even better setting that the makers might not have had). Although Quora moderation is notably inconsistent, being inflammatory (as people tend to be in debates that progress too long) could lead to one's account being reported and banned, like on a typical social network or forum.

The same concept is present in 2834: Book Podcasts.

#2725: Sunspot Cycle

January 16, 2023



Who can forget the early 2010s memes? 'You know you're a 90s kid if you remember the feeling of warm sunlight on your face.' 'Only 90s kids remember the dawn.'

Explanation

The solar cycle is a roughly 11-year cycle of changes in the Sun's activity (sunspots, solar radiation, ejecta, and solar flares), from a period of minimal activity to maximum solar activity. Researchers use specially modified telescopes to study the sun. Sunspots are areas on the sun which are slightly less hot than the surrounding material, so they appear as dark patches when viewed through these telescopes, but they do not meaningfully impact the amount of light that reaches the Earth.

This comic imagines an alternate reality where sunspots are literally black patches on the surface of the sun, void of all luminance, so the amount of light that the Earth receives swings drastically over an 11-year cycle. As the text above the chart suggests, the inhabitants of Earth in this reality are so accustomed to the extreme decade-long cycle of darkness and light that they don't even consider why it's pitch black for 10 years straight, and so Randall helpfully created this chart to explain.

Below is a graph showing the number of sunspots as a function of time from around 1965 to 2025. During the periods of heightened solar activity, the area of the graph is shown in black, while lighter periods are shown as white. For clarity the troughs are labeled with the sun being bright or dark. It is always when there are few spots that the sun is either completely free from spots and thus bright, or completely covered and thus dark. The

maxima are always during the height of the transition between the two extremes, with a wide swathe of the time around the minima being mostly light or mostly dark, alternating at around a decade of each predominating.

All this would obviously be catastrophic if it happened in our version of the universe, as during a dark phase insufficient light would be coming from the Sun, and the Earth could freeze if all the energy from the Sun was reduced. If the spots only affect light in the visible spectrum, then Earth would not freeze but plants would have trouble with photosynthesis and other natural processes would be interrupted. In our universe sunspots cool the area of the Sun where they appear, relative to the rest of the surface (50-75% of the nearly 6000K 'norm'), but they are far from being actually dark; NASA says that each sunspot on its own would glow orange, brighter than the full Moon. So even in a completely sunspot-covered Sun, the Sun would still be brighter than (with a typically bright Sun illuminating it) the Moon, and far brighter than the dark-time Moon would become (possibly causing issues for nocturnal life, as well). It would be possible to see it (and see by it) even if the heat delivered were very low and even noon would seem to be crepuscular by our normal expectations. These problems are obviously not a serious threat in the reality of the comic, as the Sun is truly dark and yet people and natural systems have long survived these dark periods and adapted accordingly.

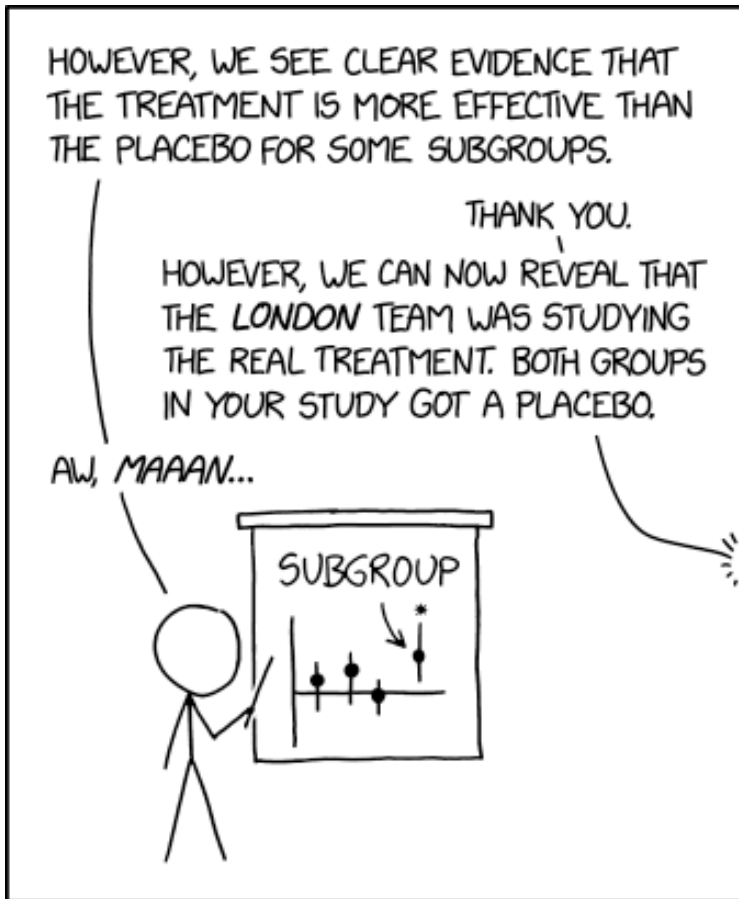
The title text indicates the effect on internet memes that

the special solar cycle has had. During the 2010s in our universe there were many '90s kid' memes. Those were also popular in this universe, but they reflect that the Earth had at that time been dark since the 2000s, and thus only those born in the 90s and before would remember dawn or the feeling of the warm sun on their faces.

Sunspot cycles were discussed in 2930: Google Solar Cycle.

#2726: Methodology Trial

January 18, 2023



RESEARCHERS HATE IT WHEN YOU DO PLACEBO CONTROLLED TRIALS OF THEIR METHODOLOGY.

If you think **THAT'S** unethical, you should see the stuff we approved via our Placebo IRB.

Explanation

When testing the efficacy of a potential medical treatment, researchers compare subjects who received the treatment against subjects who received a placebo. Usually each subject does not know whether they received the treatment or placebo, and neither do the practitioners, until the end of the trial. This distinguishes the actual effects of the treatment from the effects of simply participating in a study. People who receive a placebo (or an ineffective treatment) often believe their treatment is working due to such causes as paying more attention to one's health or expecting to feel better. This misattribution of effect to a non-treatment is called the "placebo effect".

In this comic a team of researchers appears to have studied some medical treatment, using a placebo controlled test. They present their findings in which a particular subset of participants (out of at least four distinct groups) shows an apparently significant result. The graph shows that three groupings have results whose error-bars indicate that they might easily have zero (or neutral) true effects, if not negative ones. But, even at the lowest extent of the accepted uncertainty, the fourth stands out as definitively having some degree of positive effect (of whatever kind this particular graph is plotting).

However, it is revealed that the 'treatment' they were given was also a placebo. Their own study was the subject of a placebo controlled test conducted on their

methodology. They were the placebo group, while a different team presumably used the exact same methodology to study the real treatment. Thus, all of this team's findings were due to the placebo effect, or else the trial size and scope allowed a purely statistical 'blip' to occur, instead of there being any real merit to the "treatment". This indicates that their methodology shouldn't be used for any real world applications. This may be a subtle dig at the recent aducanumab Alzheimer's drug trial controversy, where post-hoc reanalysis of one subgroup of patients revealed a surprising result when the overall trial had otherwise failed.

The particular flaw in the methodology appears to be dividing too few subjects into too many sub-groups, allowing a chance cluster of anomalous results to overly influence an apparent result. The researcher did find significance in one sub-group, even though in reality there was no signal, just noise, since it was all placebo groups. This references the same p-hacking problem as 882: Significant. Only in this case the researcher themselves is the subject of the real trial.

If the non-placebo study had the exact same size and design (as it should have, in such a meta-study), it would cast doubt upon whether any similar-looking findings in London were significant. Especially if they also found that the same subgroup were again exhibiting the sole significant effect, which might reveal an inbuilt flaw in the procedure. On the other hand, it could just further show how likely any particular grouping was to falsely

show a result; if all groups had apparently benefited, the chances are that most of them were correct, whether or not further research is needed.

Treatments can be more effective on specific subgroups of the population; for example, an anti-cancer drug might only work against specific mutations that cause cancer. But any such result needs to have appropriate statistical significance and new subjects from that subgroup should be tested to ensure the result is repeated.

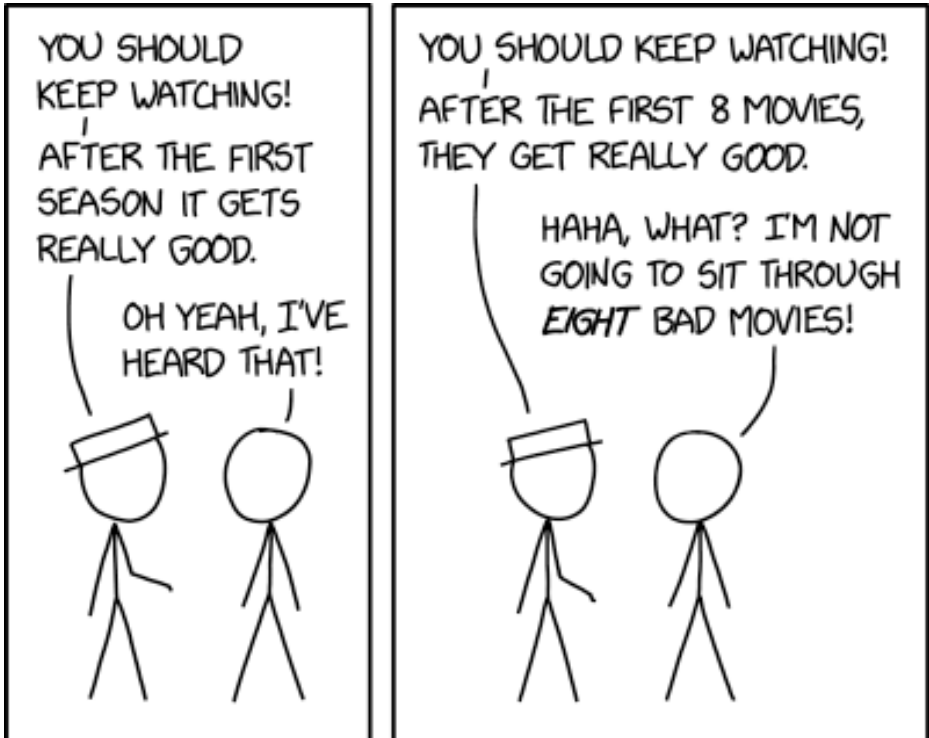
The title text points out how the experiment has almost certainly violated some set of ethical standards, because one researcher offers what he believes to be genuine treatment to a large number of participants only for a third party (the offscreen speaker) to replace all his medicine with placebos, ultimately deceiving the patients. The title text implies that it was approved by a genuine Institutional Review Board (IRB), the group which decides whether a proposed experiment is ethical to perform. However they also have a "placebo IRB", presumably made up of people who have no qualifications to make such judgements well, or perhaps not made up of people at all, but simply a mechanism for generating random decisions.

However, such a methodology trial using all placebos wouldn't necessarily be unethical. In addition to using a placebo, most studies are "double blind" meaning neither the patients nor the doctors/nurses treating them know who is getting the placebo and who is not; only the

researchers conducting the study know. This is so doctors/nurses cannot inadvertently let the patients know who is getting real medicine (by acting with remorse around patients they know are not being treated, or being more cheerful with patients they know who are). It is considered perfectly ethical for doctors to give patients what they believe is medicine but is not (the placebo). This is because without the double blind procedure it may not be possible to identify real medicines from ones that have no effect, and the impact of preventing real medicine from being used by millions is greater than the deceit towards the small number receiving a placebo in the experiment. By extension it could be ethical to have the researcher conduct a trial with two placebos without knowing it. For instance if the London team and the team in the comic were finding beneficial effects in new drugs that other researchers found had no effect (or finding other drugs didn't work when others had evidence they did) then it may be worth investigating if their shared methodology has the flaw demonstrated in the article. That way regulatory agencies could exclude their flawed data when they make decisions on what drugs to approve, while the two teams could shift to a better methodology and return to contributing to medical science.

#2727: Runtime

January 20, 2023



IT'S WEIRD HOW IT'S WAY MORE NORMAL AND SOCIALLY ACCEPTABLE TO SUGGEST SOMEONE SPEND 10-15 HOURS WATCHING SOMETHING WHEN IT'S TV RATHER THAN MOVIES.

At least there's a general understanding all around that Doctor Who is its own thing.

Explanation

The comic presents two separate conversations, which boil down to the same premise and yet differing conclusions. In one, a particular TV show is being watched, in the other a film franchise.

While it is finding its feet, a new season of a television show (perhaps commissioned, on the back of some perceived interest in the story it will tell, for a dozen or so episodes of around 50 minutes - i.e. about ten hours) is not necessarily going to get everything right in the writing style, the slant it puts on the subject matter, the cast of characters or other production values. Or at least not for mass appeal to the everyman, for whom Cueball is the archetypal representative. Nevertheless, many series do get further seasons and greatly improve. White Hat (the optimist, and clearly won over by the production) is on the way to successfully convincing Cueball to view a particular series, or perhaps to continue to watch it after becoming jaded by its early failure to live up to its hype. It sounds reasonable to Cueball, just from his friend's recommendation, to get over the hump and appreciate it "when it gets good".

A series of films, however, is seemingly a different matter. By substituting 10+ hours of filmed-for-television with something more cinematic, the prospect of getting over a similar 'hump' in a long-running set of sequels. While the total runtime of movies varies, and the total runtime of television seasons varies even more, Randall estimates

that 8 films and a season of television will both run between 10 and 15 hours.

There are legitimate reasons why people might treat these situations differently:

- A television series that gets good can be expected to run for at least five seasons, whereas nine movies is already quite long for a movie series. The ratio of 'good' to 'bad' content is likely to be much better for a television series.
- Watching a television series is generally more convenient than watching multiple films. While streaming has lowered the barrier to watching movies, each one still requires a continuous block of time and attention (usually between 90 and 120 minutes). TV episodes historically ran from 23 to 46 minutes, and still generally run less than an hour each. This makes it easier to fit the content into a busy schedule.
- The longer run-time of a movie generally means that a film series will focus on one specific plotline in each entry, whereas televised series are or can be more episodic (the characters are involved in a different situation each time) and can also interweave plotlines throughout individual episodes or episode arcs, so that less time per episode is spent on plots viewers dislike.
- In the US, a film typically begins shooting from a completed script with only minor revisions conducted once filming starts; whereas in television, writers are usually engaged throughout most of a series' season and can more quickly change unpopular elements in future

episodes.

The mention of “after the first 8 movies” might be a reference to the long-running Fast and the Furious franchise, which now has 9 movies (plus a couple of spin-offs) at the time of this comic’s publication. The more recent movies are well-reviewed (rated “fresh” on Rotten Tomatoes), even though the first four were widely panned by critics. Someone like Randall, who may have ignored the franchise when it first came out in 2001, may be wondering if he should watch the more recent ones that critics generally like; and, if so, does he need to catch up on the initial movies first?

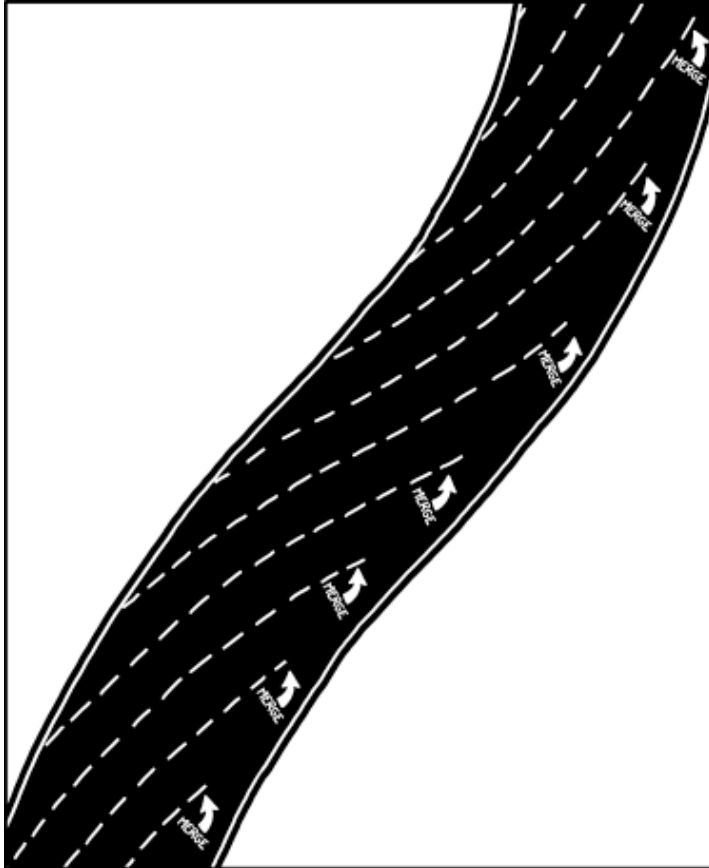
The title text talks of the long-running British TV series that is Doctor Who. The original Doctor Who, running from 1963-1989 was typically low budget, for its time and locality, though initially considered cutting edge in many ways. Compared to more modern classics, and especially Hollywood sci-fi, it would be noticeably not as good. The revived series (2005-present) has a much higher production budget and is typically much more aligned to modern viewers, who may willfully ignore or not even know of the older episodes. Someone just starting to watching Doctor Who sequentially from the very first season (broadcast in 1963) would have to watch hundreds of episodes (26 'seasons', by some counts) before the series "gets good" to modern eyes, if the "good" point is the 2005 series revival, or even quite a few to reach any given key point in the original run. What's more, trying to watch the series from the beginning is literally impossible because dozens of episodes have

become lost media over the decades, with the footage erased by the BBC (though the audio from every episode has miraculously survived). Thus Doctor Who is considered to be its own thing, and unlike other shows where the fans recommend you suffer through a poor first season to enjoy improvement in subsequent seasons, Whovians might recommend potential new fans to begin with the 2005 reboot (technically the 27th season), which was produced to appeal to all new-comers without even necessarily any cultural knowledge of what had been broadcast up until the long hiatus a decade and a half before.

It is vague about Randall's precise opinion, but even the most dedicated fan would acknowledge that it has had a varying quality/charm/consistency/etc, according to one's personal tastes for such things. Comparing the original run (pre-Millennium, featuring seven key actors sequentially taking on the title role over more than four decades, and another for a standalone TV-movie) with the revived series (continuing the pattern with a similar number of additional title-actors in just half the time), and any number of 'show-runners' (producers, main writers, etc) is one possible point of contention, probably more suited to British viewers. Possibly, in Randall's case, it is just the (perceived) ups and downs in the more recent era, which has been more consistently screened in the US.

#2728: Lane Change Highway

January 23, 2023



I GOT FIRED FROM MY TRAFFIC ENGINEERING
JOB FOR BUILDING A HIGHWAY WHERE YOU
COULD ONLY TRAVEL BY LANE CHANGES.

I just think lane markers should follow the local magnetic
declination.

Explanation

Highways are large roads designated for high-speed traffic. Like in 253: Highway Engineer Pranks, Randall proposes an ineffective highway design, which reportedly got him fired.

Highways normally have several, but not a fixed number of lanes; more lanes may be included on parts of the highway with higher traffic flow, and the design decision can interact with entrances and exits to the highway. One common structure is to merge a lane from the right to the left after an entrance, to remove the extra lane created by the merge of the entry ramp. Drivers are expected to merge into one of the lanes further left before the lane on the right ends.

Here, Randall has designed a highway where the lanes are not aligned to the road, thus constantly expanding to the left and requiring merges from the right. This is highly impractical, as each individual lane merge is a difficult maneuver compared to normal driving; being forced to perform these near-constantly is a large hindrance at the least and a large danger at the most.

Effectively every car would have to drive with their left turn blinker on constantly in order to drive in a regular straight line. Alternatively cars could stage their lane changes which would make them swerve gently back and forth across the road. Since everyone will choose a different strategy, the road would be chaos. People

would almost never try to make a right lane change since lanes to the right end sooner.

While considerably less extreme, a section of U.S. 101 "North" (which is actually traveling west) in southern California is somewhat like this. The road is four lanes when crossing over I-405, with an additional lane immediately entering on the right from I-405 South, but three of these lanes become exit only lanes in the San Fernando Valley (at Haskell Avenue, Havenhurst Avenue, and Topanga Canyon Blvd) and two in Ventura County (one in Thousand Oaks and one in Ventura), so all through traffic must merge into the two lanes that enter on the left carrying traffic from I-405 North.

The title text refers to local magnetic declination, the angle between the magnetic north pole and the true (geographic) north pole. This is almost always not aligned with road directions, so lanes following it would slant across the road as in this comic. In addition, magnetic declination varies over time due to polar wandering, so the lane markers on the highway would need to be regularly updated.

#2729: Planet Killer Comet Margarita

January 25, 2023

THE PLANET KILLER

COMET ICE MARGARITA

INGREDIENTS


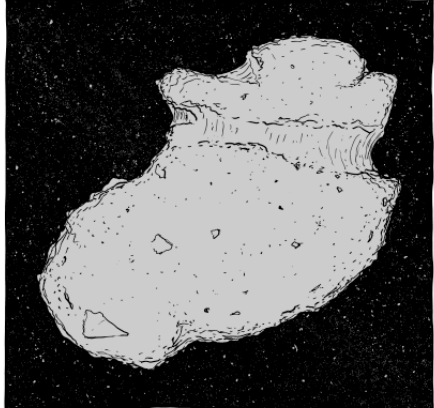

4,000 OIL TANKERS FULL OF TEQUILA

1,000 TANKERS FULL OF ORANGE LIQUEUR

1,000 TANKERS FULL OF AGAVE




THE JUICE FROM 20 TRILLION LIMES

ONE COMET NUCLEUS



INSTRUCTIONS

- ① DRAIN LAKE MEAD, COMBINE INGREDIENTS BEHIND HOOVER DAM
- ② DETONATE COMET USING BRUCE WILLIS'S DRILLING RIG FROM ARMAGEDDON (1998)
- ③ DISPENSE DRINK THROUGH HOOVER DAM TURBINES



I'll take mine on the rocks, no ice.

Explanation

A margarita is a popular cocktail made from tequila, agave, triple sec, and lime juice. The frozen margarita variety is blended with ice, and this comic suggests making an enormous drink using the ice from a comet nucleus – the one depicted having more than a passing similarity to the much-studied 67P/Churyumov–Gerasimenko (but then if it is 67P/Churyumov–Gerasimenko, could you at least remove Rosetta (spacecraft) and Philae (spacecraft), please?). Based on the amount of ice in a typical comet, it extrapolates the quantity of the other ingredients. The mixed drink is big enough to fill Lake Mead, a massive reservoir on the Colorado River created by the water held by the Hoover Dam.

Beyond the unusual quantities and mixing method, Randall uses the general term "orange liqueur" here rather than specifying triple sec. Assuming that each oil tanker holds the same amount of liquid, the tequila: triple sec ratio in the comic is 4:1, meaning more tequila is used than necessary (the ratio should be 5:2).

Armageddon is a movie starring Bruce Willis about a team of astronauts and oil drill engineers on a mission to blow up an asteroid that's on a collision course with the Earth. The oil drill would be used to drill a hole deep into the asteroid, into which they'll drop a nuclear bomb to destroy it. The comic suggests using the same technique to explode the comet nucleus to get the ice. It should be

noted that consuming any cocktail which has been infused with the radioactive byproducts commonly resulting from the detonation of a thermonuclear weapon may pose health risks which exceed those typically associated with the consumption of alcoholic beverages in general.[actual citation needed]

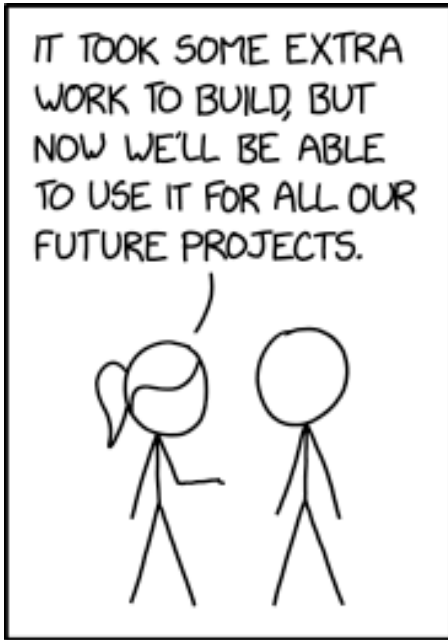
In the title text, he asks for it "on the rocks", with no ice. In the context of normal cocktails, "on the rocks" means to serve with ice. Here the cocktail is served from the drained basin of Lake Mead, which has rock as a substrate - hence "on the rocks." In addition, the comet nucleus contains lots of rocky material, so "on the rocks" with Randall's planet killer cocktail would also be served with literal rocks in it.

In the header, it says "Today's comic was drawn for Daniel Becker, based on his winning question submitted to the What If? 2 contest." As explained in the What If? entry melting a comet on Earth has enough negative effects on the climate to negate the cooling effect a couple of thousand times over – thus this margarita may proudly wear the title "planet killer".

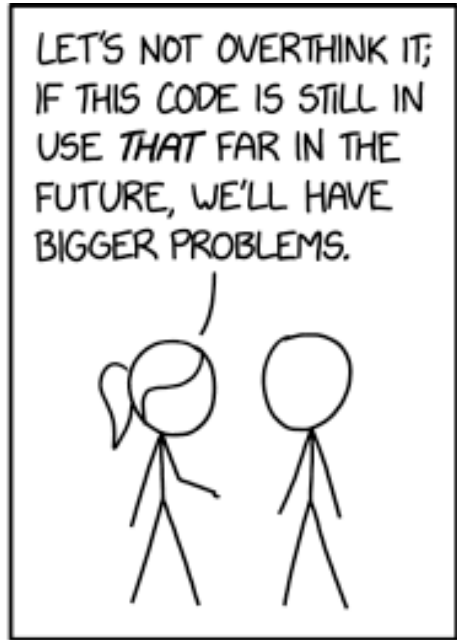
Assuming an average oil tanker size of 25.8 million gallons, this provides approximately 1,700 servings of tequila per adult on the planet. Therefore it is a planet killer in terms of alcohol poisoning and killing off all humans of adult drinking age.

#2730: Code Lifespan

January 27, 2023



HOW TO ENSURE YOUR
CODE IS NEVER REUSED



HOW TO ENSURE YOUR
CODE LIVES FOREVER

Surely (no one/everyone) will (recognize how flexible and useful this architecture is/spend a huge amount of effort painstakingly preserving and updating this garbage I wrote in 20 minutes)

Explanation

This comic contrasts two scenarios involving Ponytail writing a computer program: in the first panel, she has taken great care to future-proof her code, while in the second, she decides not to under the assumption it will soon be deprecated and/or replaced. The captions below each panel note that, ironically, code that was written with future-proofing in mind will often quickly cease to be used, defeating the purpose of future-proofing, while the code that was not will often be used much longer than the original programmer(s) intended. This is a Catch-22 situation that many developers have experienced; the first one even has a name, YAGNI.

The second panel could be an allusion to the Year 2000 problem, although it is important to note that problem was not simply due to developers not thinking ahead but also because the developers were working with extremely limited computer resources at the time, promoting the use of 2-digit years.

The title text is a modular sentence with two parentheticals, each containing two alternative phrases. This allows for four permutations of the sentence, each of which may be said by programmers. The following two permutations may be the hoped-for ideals of software developers:

- "Surely everyone will recognize how flexible and useful this architecture is."

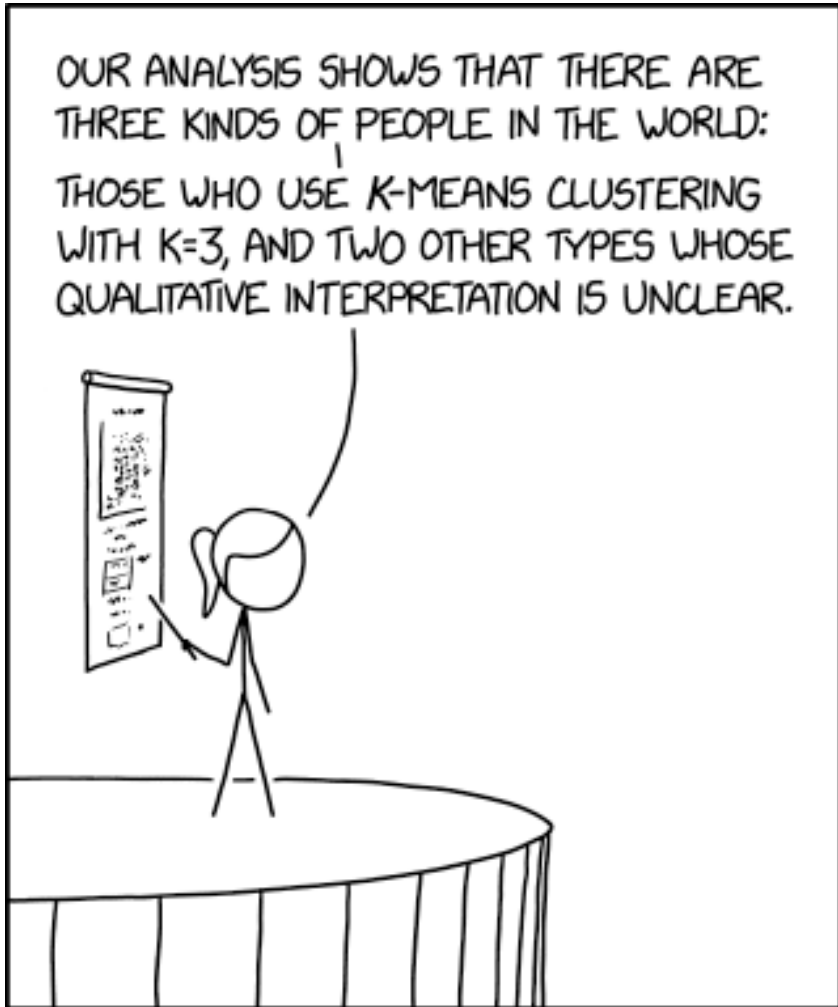
- "Surely no one will spend a huge amount of effort painstakingly preserving and updating this garbage I wrote in 20 minutes."

However, reality often falls short of such hopes, in that insufficient numbers of people recognize code intended for re-use, and far more people than intended will attempt to maintain and adapt sloppy work. The former can occur because of uncertain or unclear assumptions which aren't clear when the time comes to re-use code capable of it, and the latter sometimes happens because the corner-cutting peculiarities of hasty work are often seen as far deeper necessities than they actually are. The remaining two permutations express these far less hopeful outlooks:

- "Surely no one will recognize how flexible and useful this architecture is."
- "Surely everyone will spend a huge amount of effort painstakingly preserving and updating this garbage I wrote in 20 minutes."

#2731: K-Means Clustering

January 30, 2023



According to my especially unsupervised K-means clustering algorithm, there are currently about 8 billion types of people in the world.

Explanation

Ponytail is giving a talk about her research groups analysis of which different types of people there are in the world.

A popular class of wry observations use the snowclone, "There are two types of people in the world: those who do A, and those who do B." Here B will usually, though not always, be some antithesis of A. The most self-referent version is the joke, "There are two types of people in the world: those who divide people into two types, and those who don't." Other well known versions include:

- "There are three types of people in the world: those who can count, and those who can't."
- "There are two types of people in the world: those who can extrapolate..."
- "There are 10 types of people in the world: those who understand binary and those who don't."

Ponytail uses k-means clustering with $k=3$. This is a method of categorizing data. To explain how it works, imagine a set of people of various heights and weights, that should be split into 3 groups (which gives k the value 3). One way to do this would be to plot the data onto a scatter chart; then pick three points at random for reference; then sort the people according to which point they are closest to, forming 3 initial groups. After forming 3 groups, the average of the data point of every

item in each group is found; these average data points are used as new reference points to once again categorize all the data into 3 new groups. This process is repeated until the data converges; that is, the data points no longer change groups even after new reference points are picked.

The k-means algorithm is quite simple, which lends to its popularity, but it has a major drawback: the analyst has to determine how many groups (or clusters) to split the data into (that is, what to set k equal to). A value of k that doesn't match the underlying structure of data can yield a partitioning that's hard to explain in terms of properties that distinguish each cluster (in other words, their qualitative interpretation is unclear).

Ponytail's determination that there are three clusters is unsurprising if she herself falls into the category of those who use $k=3$ as a fixed value, which will inevitably result in three data clusters. However, the joke is that while one group's trait is "uses $K=3$ ", this logically means all the data that isn't in the group does not use $k=3$... except that with two other groups, then that description applies to both, meaning what distinguishes the other two groups from each other is unclear.

In the title text Ponytail, or maybe it is Randall, claims that: "According to my especially unsupervised K-means clustering algorithm, there are currently about 8 billion types of people in the world."

This seems to be Randall saying that every human is unique and cannot be meaningfully clustered together in

groups. The human population passed 8 billion on 2022-11-15 two and a half months before this comic came out.

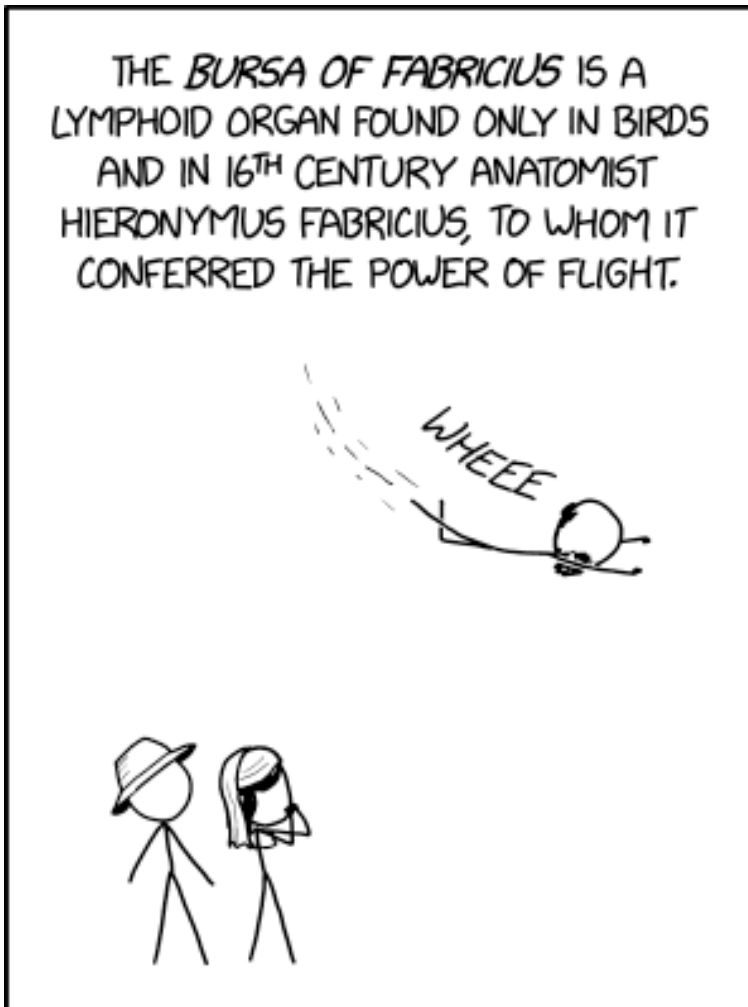
The title text uses the K-means algorithm with an absurdly exaggerated variant of this problem. If the number of clusters is equal to the number of data points, each point will be assigned to a separate cluster for which there is an exact match; in other words, each member is the sole member of its own group. With such parameters, it makes it impossible to meaningfully comment on similarities between any two members. This is humorous because it would make the result useless for the purposes for which clustering algorithms are typically used, such as making insurance risk pools or targets of advertisement campaigns. In assessing whether k or $k \pm 1$ clusters are more useful to describe data, a weighting related to the number of clusters, or the numbers of points per cluster, might encourage identical clusters (for exactly coincident member points) to be merged, as it should for near-identical source data such that it sufficiently embraces clustering - yet Randall's unconstrained algorithm seems to have no such metric and stops at the 'perfect' initial assumption where $k=n$.

Interestingly, by including the entire human population, the algorithm should be immune to bias in creating its input data. However, if every human is unique as Randall's algorithm claims, the only way to have the clusters converge is to "throw out" some traits of humans as unimportant. This may be objectionable to humans who disagree with that assessment. In contrast, in a

supervised algorithm, the training data is tagged with traits that the trainers seek. These traits could be applied in a manner that is socially unacceptable, and lead to AI behavior that reflects the biases of the trainers.

#2732: Bursa of Fabricius

February 01, 2023



If an anatomical structure is named for a person, it means they were the only person to have it. Pierre Paul Broca had a special area of his brain that created powerful magnetic fields, enabling him to do 19th century

fMRI research.

Explanation

The Bursa of Fabricius is an organ found in birds that is necessary for the development of their immune systems.

This comic claims that the 16th century anatomist Hieronymus Fabricius (for whom the organ was named) had that organ and therefore was able to fly like a bird. However, despite being found only in birds, this organ does not in fact contribute directly to flight. Also, given that it only exists in birds, it is doubtful that Fabricius also independently had this same anatomical feature.[citation needed]

Many scientific and mathematical discoveries, including anatomical structures, are named after the people who discovered or described them. For example, the islets of Langerhans were discovered by Paul Langerhans. Likewise, rare diseases are often named for the doctor who first describes the disease to the medical community, or for a researcher who identifies the specifics involved. They may attempt to set their own name to it, for posterity, or they are later honored in this manner by those who recognize their vital contribution to the field, such as with Parkinson's disease.

In other cases, rare diseases are named for the first or most famous (possibly even the only) person known to have had the disease. For instance ALS is commonly known as Lou Gehrig's disease in the US because of baseball player Lou Gehrig having notably developed the

condition. Outside of the US, it may be more known just as "amyotrophic lateral sclerosis" (alternatively "motor neurone disease") or, for simplicity, the initials ALS (or MND).

The title text continues with the idea from the comic claiming that anatomical structures are solely possessed by the human for which they are named, in another similar example. Pierre Paul Broca, a French physician, anatomist and anthropologist, was known for his research on what is now known as Broca's area, a region of the brain used for speech and language processing. The premise being that, having this feature, he was uniquely gifted with the special ability to created powerful magnetic fields, enabling him to do fMRI research in the 19th century. Later in the same year, Broca was again referenced in 2780: Physical Quantities.

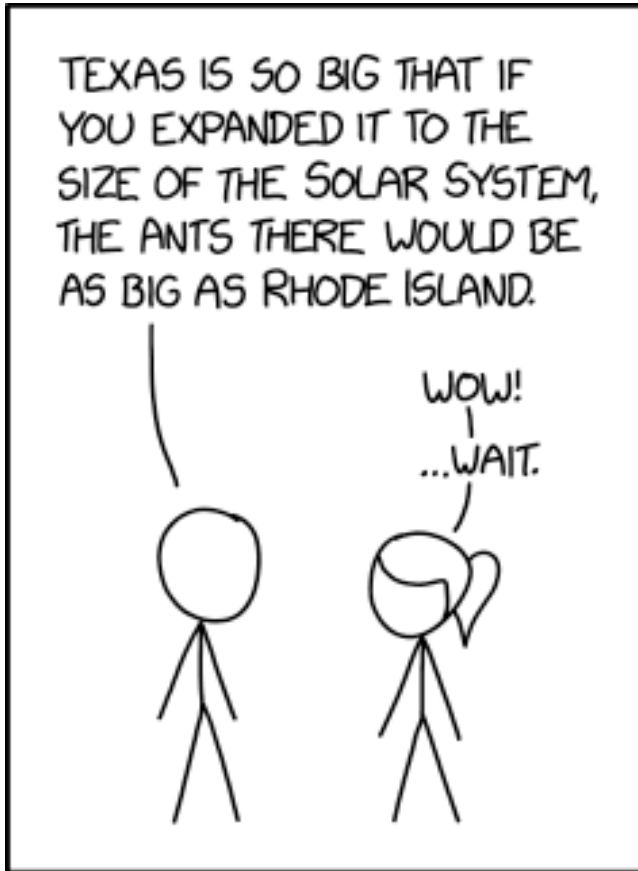
Broca did not[citation needed] do fMRI research, a powerful method of non-intrusively imaging and analyzing the internal structures of the living human body (amongst other things), as it was not invented in his lifetime. Nor is it likely that this ability could be 'naturally' possessed by any individual, such as he. He did, however, physically study brains of known speech-impaired patients who had then subsequently died, determining what damage (in the area of the brain which was then to be named for him) was directly related to their specific group of ailments. Today, we can safely view this area in living people, using fMRI, and directly connect what we see with the current condition of patients. This increases our knowledge of the brain, as

with the mythical abilities Randall gave Broca, but also possibly even allows us to help those currently under the effects of any observed damage (not necessarily possible by any 19th century physician, even with this superpowered form of vision to assist them).

In reality, if Broca was the only person to have ever possessed Broca's area then this might have meant that only he had ever had the power of speech (as we understand it), which would indeed give him a very special ability; but one begging a number of other vital questions, if only anybody else could have asked them...

#2733: Size Comparisons

February 03, 2023



MY HOBBY: UNHELPFUL
SIZE COMPARISONS

If you shrank the Solar System to the size of Texas, the Houston metro area would be smaller than a grasshopper in Dallas.

Explanation

Another comic in the My Hobby series.

Cueball attempts to emphasize to Ponytail the size of Texas (the largest state in the contiguous United States, and the second largest US state overall), by making a size comparison. He states that with Texas expanded to the size of the Solar System, the ants in Texas will be as large as Rhode Island (the smallest US state). However, Cueball on purpose (according to the caption) just proves how small Texas actually is compared to the Solar System (which is a lot larger).[citation needed] Additionally, the deeper truth of the original statement is inverted; if a much smaller state (Rhode Island, Delaware, etc.) were scaled up to the size of the solar system, its ants would be the size of Texas itself, over 200 times as large as the scaled up Texan ants, so the relative smallness of the Texan ants shows how big Texas is.

A common analogy for expressing a statistic (such as area/volume/population size/population density) of unfamiliar things is to compare that thing to some other reference that people are likely to already have an understanding of, if only through past comparisons. For instance, it is said that a human-sized flea could jump the equivalent height of the Eiffel Tower (if jumping ability scaled with animal size; which it does not). In this case, Randall is comparing objects that are extremely different in scale (the state of Texas and a small insect), but then blowing Texas up to yet another size many orders of

magnitude larger, and then comparing it with something else his addressee has likely no comprehension of, with the result that the comparison is of no value in understanding how big Texas is (which could be supposed to be Cueball's intended impartation), or what ants have to do with anything in the first place.

There are a lot of definitions for how large the Solar System is, but one that is used (and easily agreed upon) is based upon Neptune's aphelion (the farthest point from Sun of the outermost planet). Using the circle area equation, we might say that the 'area' of the solar system is 6.49×10^{19} square kilometers (2.506×10^{19} square miles), which is a lot, with Texas's area being in turn measured as $696,241 \text{ km}^2$ ($268,820 \text{ mi}^2$). The difference in size is the huge factor of 9.32×10^{13} (not a simple number). Ants, unfortunately for the calculations, vary vastly in size, but Rhode Island's area is known to be $3,144 \text{ km}^2$ ($1,214 \text{ mi}^2$). We can therefore back-calculate that Randall's average "ant" would occupy 33.73 square millimeters. Roughly measured, an ant has an "aspect ratio" of 1:2 (width to length), and such an assumption leads to a length of 8.21mm, which falls easily into the range of 2–25mm for various possible species and types of ants. Therefore, Randall's calculated comparison indeed holds up as valid.

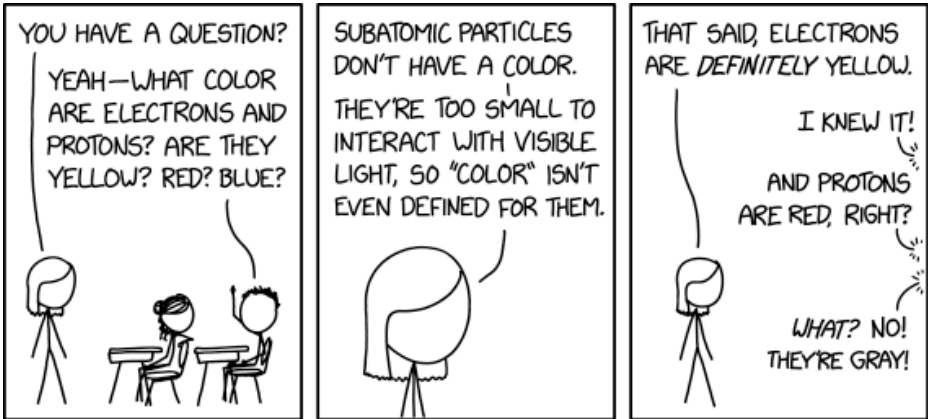
The title text refers to the opposite, with the entire Solar system being scaled down to the size of Texas. Houston (a city in Texas) has a metropolitan area (an area extending a bit beyond the city itself) that, if shrunk by the same factor as before, would be smaller than a

grasshopper in Dallas, another city in Texas. This is doubly confusing as the comparison made is between a shrunk object (something in Houston) and an unaltered object (something in Dallas) in the same reference frame (Texas). The calculations to verify this hinge upon Houston's metro area normally being considered to be $26,061 \text{ km}^2$ ($10,062 \text{ mi}^2$), and hence becoming 279.6 square millimeters. A grasshopper may be considered thinner than an ant, so we shall use the aspect ratio of 1:3 instead, to give a length of 28.96 mm, or almost 3 centimeters and approximately an inch. This falls within the range of 1–7cm range, that may be found quoted in some places, but is significantly smaller than notably large species. Whether the Dallas grasshopper is any particular variety (or even a native, rather than an exotic pet) is not expounded upon and thus it's actually irrelevant if the grasshopper is from Dallas - which adds to the confusion mentioned before.

On the other hand, the comparison would be meaningful the other way around: "The Solar System is so big that if you shrink it to the size of Texas, (the shrunk) Rhode Island would now be as small as (unshrunk) ants".

#2734: Electron Color

February 06, 2023



There's quark color, but that's not really color--it's just an admission by 20th century physicists that numbers are boring.

Explanation

In this comic Miss Lenhart is teaching a school physics class. One of her students asks what the color of electrons is.

This is a relevant question for a kid to ask since on many scientific diagrams of atoms, the subatomic particles have been assigned colors to identify them for the reader. Neutrons are generally red, green, or gray; protons red or green and electrons might be blue or yellow. But there is no accepted rule for coloring such diagrams, so the kid may be confused. Additionally, some scientific diagrams use color coding rather than actually representative colors, and the kid may be wondering what color particles actually are.

In completely off-character style, Miss Lenhart actually gives a correct fact ...so "color" isn't even defined for them. and states that, unlike the diagrams, which are colored for convenience, the particles are not colored. She however gives an inaccurate explanation: They're too small to interact with visible light, ... In fact, every optical effect in our world is due to electrons interacting with light. That leads to color because the electrons are usually bound to various atomic nuclei in molecules etc., which leads to differences in how they take up and give out various energies of photon. But the electron itself does not have a particular hue that can be shone upon and absorbed/reflected, it merely governs the possible quanta of energy changes involved in generating the broad

spectrum of light that the substance formed of the atom(s) may be seen by. Also protons are far "bigger" than electrons (and would interact strongly!), but their interaction with light (and generally electromagnetic radiation) is rarely observable, because they are shielded by the tiny electrons in ordinary matter. So, whether intended or not, Miss Lenhart is in her usual role of talking bullshit malarkey, also see for instance 1519: Venus.

She then continues by saying that electrons are definitely yellow. The reason for this isn't clear. She may be:

- meaning that they should be yellow on diagrams, because she feels this is the correct way to depict them in drawings of atoms,
- referring to the Greek etymology of the word electron (elektron is an old name for amber, a yellow gem),
- merely teasing her young pupils, or
- stating how she feels they would be, if they could possess color.

But her off-panel pupils take her word for it. One of the kids says "I knew it", to the "fact" that electrons are yellow, and likewise the other pupils completely ignore what Miss Lenhart just told them. The debate then starts as one pupil claims "and protons are red?", and another chimes in, with a "No, they're gray!" This only makes sense in a debate of how to draw atoms, not regarding their actual color, as Miss Lenhart just explained.

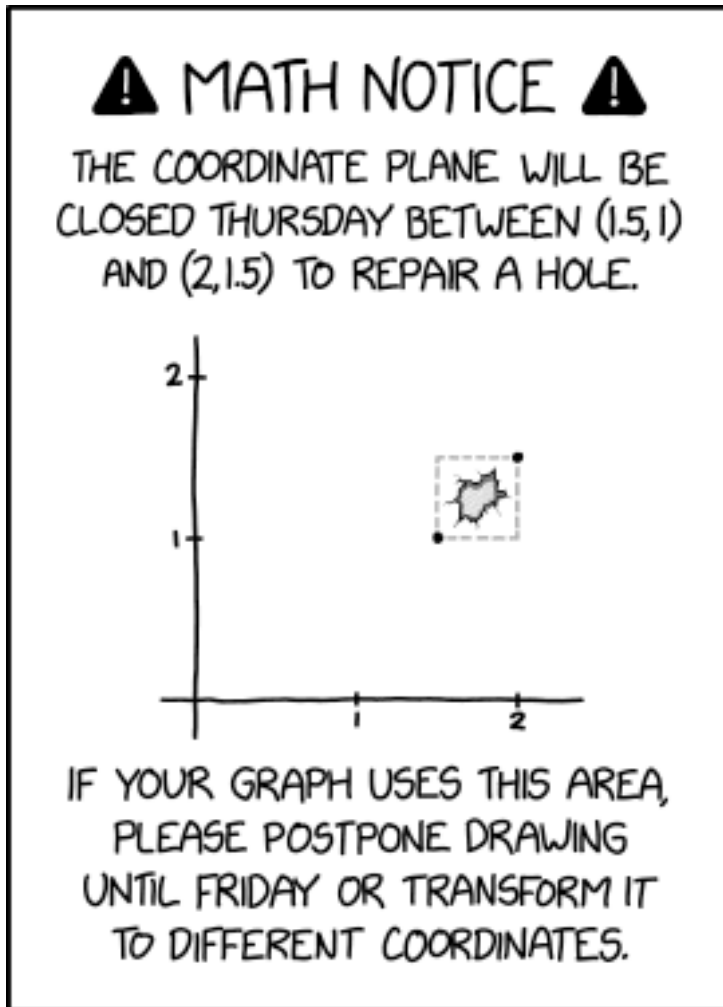
The opinions over the colors are probably based on what kind of diagrams people were initially exposed to, leading to a predisposition to think that those colors are 'correct'.

Although individual electrons do not have a color, it's possible to produce a solution of so-called 'solvated' electrons. In ammonia and amines, in certain concentrations, the solution color is blue, and in higher concentrations metallic gold to bronze.

The title text refers to the color charge property of quarks, a property which is part of quantum chromodynamics. In quantum chromodynamics, a quark's color can take one of three values or charges: red, green, and blue. An antiquark can take one of three anticolors: called antired, antigreen, and antiblue. As mentioned by Randall, these have nothing to do with color as we know it, but is just a way to represent interactions between quarks in a sufficiently analogous fashion that avoids inventing entirely new words to describe a particular threefold quality of the necessary inter-quark groupings. And he jokingly says that the 20th century physicists that came up with the three color system did this as an admission that numbers are boring. They could just have called the color charges "1", "2" and "3", though this may imply an unwarranted hierarchy, progression or other standard mathematical relationship that does not actually apply.

#2735: Coordinate Plane Closure

February 08, 2023



3D graphs that don't contact the plane in the closure area may proceed as scheduled, but be alert for possible collisions with **2D** graph lines that reach the hole and unexpectedly enter **3D** space.

Explanation

This comic is a "Math Notice," which is presumably a warning or reminder for mathematicians or others who interact with the field of mathematics, in a similar way to how a "Travel Notice" may prewarn drivers of planned road closures for repairs (or rocketry). It also has similarities to that of a Notice to mariners or air missions, where nautical or aeronautical navigation might be impinged by an area (or volume) that should be kept clear from in the near future, and to notices from websites or software providers about planned maintenance, which alert users about upcoming outages. Specifically, this notice advises those who are using the coordinate plane to avoid drawing any graphs in the area with a hole until the damage is patched or fixed.

The joke may have been inspired as a response to the 2023 China balloon incident, which occurred a few days earlier. This had occasioned one of the largest temporary flight restrictions, with a closed airspace as a response, in U.S. history.

Coordinate planes are used in math for drawing graphs. The joke here is that a small section has been "closed for maintenance," likening the concept of a coordinate plane to an actual physical platform used by math, which is therefore vulnerable to damage such as is shown in the comic. In reality, the coordinate plane cannot be damaged as it is not a tangible thing.[citation needed]

Closure in mathematics can be a term relating to sets, specifically operations on sets, and a coordinate plane is a particular set of numbers. A set is closed under an operation if all the "answers" to the operation are also in the set. The coordinate plane is said to be closed under vector addition for example - adding together any two coordinates produces another coordinate in the plane. Many functions and operators may be said to have closure on the real plane, and this comic may be a pun on that term. However, if there actually is a hole in the plane, then suddenly the plane will no longer exhibit closure.

Also related to closure is the closure problem. Put simply, the closure problem is to find the highest or lowest weight of a closure in certain types of graphs. This comic may also be talking about the closure problem, as it talks about a hole in the graph, and to minimise it would be referring to the closure problem.

Closure can also be used in another sense, relating to the topology of a set; roughly speaking, a description of what parts of the set are "close" to others. In this sense, if one takes the closure of a plane with a hole, the result is indeed an intact plane, provided the hole is sufficiently (infinitesimally) small.

The title text notes that 3D graphs that cross the relevant x and y coordinates, but with non-zero z coordinates whilst in that zone, should be fine, since the hole only exists in the plane where $z = 0$. However, if they pass close - i.e. the z coordinate is small in this region - they

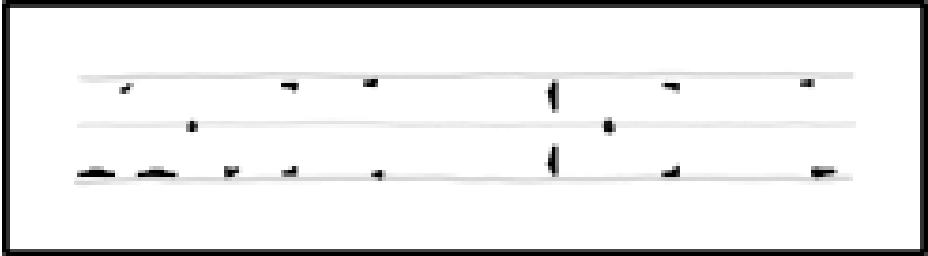
should be wary of two dimensional graph lines suddenly becoming three-dimensional and interfering with them. This could be because they have intentionally entered three-dimensional space to avoid the closure, or possibly they have inadvertently been 'launched' above/below the plane by the torn and warped edges of the surface. Or they simply fell into the hole, thus entering 3D space. This is similar to warnings to road traffic in open lanes being warned of traffic merging from lanes that have been closed due to works or any other general warning of increased congestion upon a parallel route used as a diversion.

The concept of 2D objects suddenly entering 3D space — in a way that creates interesting drama and conflict — is the subject of a book, *Flatland: A Romance of Many Dimensions*, that Randall has referenced repeatedly, such as in 721: Flatland.

In 2956: Number Line Branch, mathematics is similarly treated as public infrastructure.

#2736: Only Serifs

February 10, 2023



INSTEAD OF SERIF OR SANS SERIF,
MY NEW FONT IS *ONLY* SERIFS.

If you ever want to get beaten up by a bunch of graphic designers, try removing the serifs from Times New Roman and adding them to Comic Sans.

Explanation

This is a play upon the main difference between serif and sans-serif fonts. Serifs are ticks, or end-bars, at the ends of lines that make up letters. Rather than mere lines, there are (for example) "feet" put at the bottom of a letter such as A, and possibly also at angles such as its peak. Fonts that use this visual decoration are called "Serif" fonts, while others do not and are thus "Sans Serif" fonts ("sans" being French for "without"). Randall is suggesting a font using only these accent pieces and skipping the "body" of the letters entirely. Of course, this renders the text basically unreadable.

In the comic, the text as a whole appears to be "Aa Bb Cc Dd", perhaps written in variant #3 or variant #540 of Caslon.

As for the title text, Times New Roman is a widely available and recognized typeface with serifs, being one of the most commonly used fonts of its type. Comic Sans is a mostly sans-serif typeface (hence the "Sans" in the name) inspired by comic book lettering. Many graphic designers dislike Comic Sans due to a history of amateurs using it in contexts where its informal style is inappropriate. Defenders claim that it is easier for dyslexics to read (although this is disputed), and that it works well in less formal, typically children's contexts. Randall is suggesting here that if you want to severely anger a bunch of graphic designers (i.e. enough to beat you up), then you should try removing the characteristic

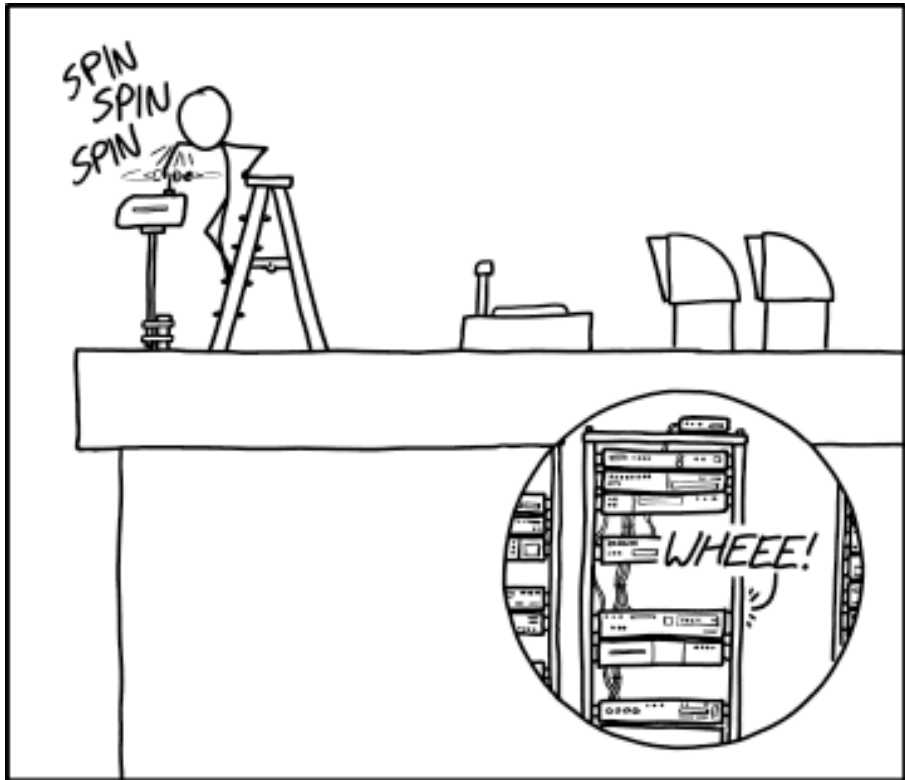
and aesthetic serifs on Times New Roman and add them instead to the hated Comic Sans – which would probably make it look even worse to a graphic designer.

One of the users of explain xkcd took the chance anyway of getting that beating and here is what it looks like normally and what it might look like after moving the serifs:

Randall has had numerous careers and hobbies where he has delighted in exploring novel methods of resolving disputes, all of which has satisfied nobody and led to him being banned from numerous events.

#2737: Weather Station

February 13, 2023



WHENEVER I SEE ONE OF THOSE LITTLE WEATHER STATIONS, I HAVE TO FIGHT THE URGE TO CLIMB UP AND SPIN THE ANEMOMETER REAL FAST TO MAKE A COMPUTER SOMEWHERE THINK IT'S IN A TORNADO.

'Pour one out for precipitation data integrity,' I say, solemnly upending the glass into the rain gauge.

Explanation

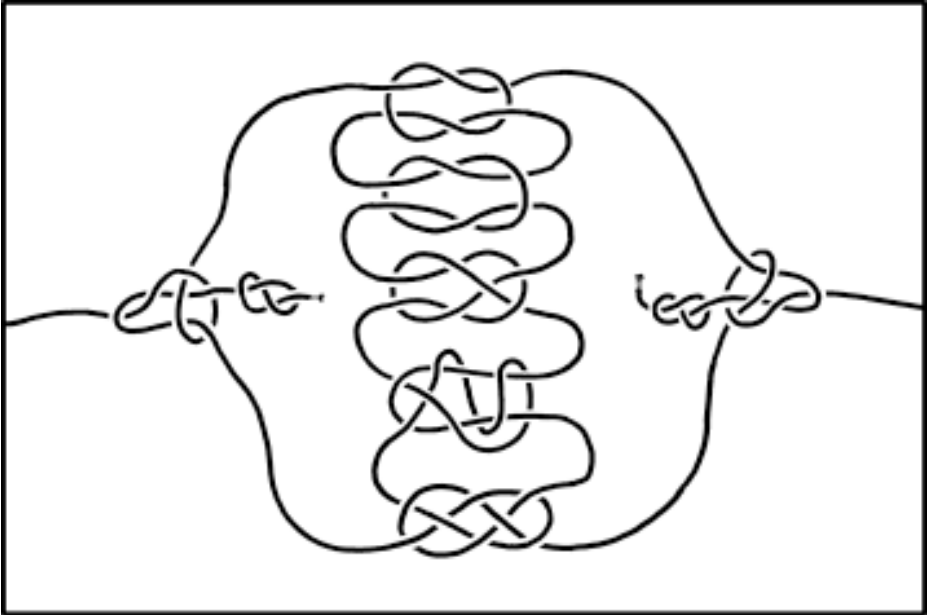
Weather stations are usually equipped to measure atmospheric conditions for weather forecasts and studies on the weather and climate. An anemometer is a device often found in such stations that measures wind speed and direction. The anemometer shown in the comic is a typical three-cup anemometer, whose spin rate is proportional to the wind speed. Thus spinning the cups quickly by hand can create an impression of fast winds and thereby excite any computers that happen to be monitoring the data and enjoy extreme weather.

Combining the speed of winds in a F1 tornado (73~112 mph; 117~180 km/h) and the speed ratio of typical three-cup anemometers ($1/2 \sim 1/3$) gives a cup speed of $\sim 16\text{m/s}$, comparing the diameter of the anemometer to that of Cueball's arm gives an upper estimate of 0.5 meters (\sim two feet), topping out at roughly 10 turns per second, which is within a reasonable range for a human.[actual citation needed]

The title text continues the trend of messing with weather equipment, this time by messing with rain gauges. "Pouring one out" usually refers to the act of pouring a liquid, usually alcohol, on the ground as a symbol of reverence for a deceased friend or relative. Thus Cueball is mourning the now destroyed (aka "deceased") integrity of the precipitation data by pouring a glass of liquid into the gauge. However, it is this very act that ruined the integrity of the data.

#2738: Omniknot

February 15, 2023



IF YOU KNOW SEVERAL KNOTS AND CAN'T FIGURE
OUT WHICH ONE TO USE, JUST TIE ONE OF EACH.

The Gordian knot is an omniknot tied using every bend in the Ashley Book of Knots, and then for extra security the upper rope at every crossing is connected to the lower with a randomly-chosen hitch.

Explanation

The comic jokes that if you have several potential knots which could be tied in a given situation, rather than being forced to choose one, you can simply use all of them and create the comic's "Omniknot." The prefix omni- means "all", and so the "all-knot" is the knot containing all the other knots (...that one knows).

Knots in the middle, from top to bottom:

- Granny knot: A knot that easily comes undone in isolation; usually the result of an improperly tied reef knot. Based upon the visible ends of rope (followed through further knots), could technically be considered a Grief knot.
- Reef knot: Also known as the square knot, one of the most commonly tied by competent amateurs. But a poor and possibly dangerous choice as a load-bearing bend, as it has a tendency to 'capsize' and untie itself, if the ropes aren't inhibited by other adjacent knots. (A "bend" is a knot that connects two ropes or lines.) Could also be described as a Thief knot, from the visible continuation of the 'ends' as followed through other elements of the omniknot.
- Sheet bend: Similar to the bowline, a popular, all-round good choice, especially if one rope is thinner than the other. If well tied, the thinner cord will cross over itself. In this case, that would be the line on the lower-right passing through the left, around it, and then under

itself.

- Double sheet bend: A more secure version of the previous knot, especially if one rope is much thinner than the other.
- Carrick bend: A very good bend, especially if both ropes are both similar in kind and thickness and cumbersome to bend (such as heavy cable) into more common knots.

On the sides are sheet bends and each rope is terminated by a figure-eight knot.

The Gordian Knot mentioned in the title text is a knot which purportedly was extraordinarily complex and nearly impossible to untie. According to legend, when Alexander the Great was faced with the knot, he simply drew his sword and cut it in half, thereby "untying" it and solving the unsolvable. The Gordian Knot is now used as a linguistic metaphor to describe a problem whose solution, rather than being to directly solve it head-on, involves working around or otherwise bypassing its apparent constraints, or simply one that is so complex as to be practically intractable.

The Ashley Book of Knots is an encyclopedia describing thousands of different knots. Though it is now dated, because it was written before the widespread adoption of synthetic fiber rope, it is still considered the reference in knot tying. Using all bends from the book and as many hitches would make the final result very complex indeed. Randall proposes here that this was the true origin of the

mythical Gordian Knot. A "hitch" is a knot that connects a rope or line to something like a post, loop, or shackle.

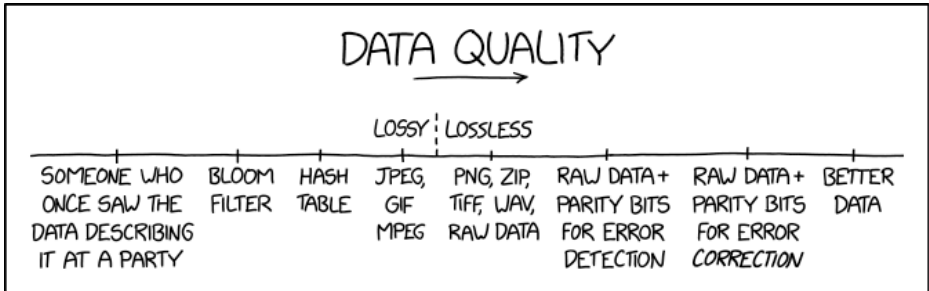
In practice, it is not recommended to use overly complex knots, as they provide little in terms of additional security compared to a well-chosen simpler knot. The ease of tying and untying, especially in less than ideal conditions, is also an important factor to consider. If strength is more important than the ease of tying and untying, splices should be considered instead of knots, as they don't weaken the rope as much.

Twitter user HollowGrin created and shared a colorized version to aid tracking the ropes.

Less than a year later a knot was used in 2880: Sheet Bend. The omni- prefix was used earlier in 2653: Omnitauro and later in 3060: Omniroll.

#2739: Data Quality

February 17, 2023



[exclamation about how cute your cat is] -> [last 4 digits of your cat's chip ID] -> [your cat's full chip ID] -> [a drawing of your cat] -> [photo of your cat] -> [clone of your cat] -> [your actual cat] -> [my better cat]

Explanation

Digital data can be compressed to make transmission and/or storage more efficient; some compression algorithms discard some information to improve the compression, which is known as lossy compression, since some of the information is lost (this can be acceptable in audio or visual data, since the difference may be hard for humans to perceive).

This comic shows a chart in the form of a line, increasing quality from very lossy to most lossless. This means that it goes, at the extremes, from having so little information as to make it effectively meaningless, to having significant extra information included (eventually making the original actually an unnecessary distraction). Some of this extra information mitigates the risk of another sense of 'loss' in data - digital data are transferred in bits, and data loss is the process by which some of these bits are lost or altered during data transport. However the highest quality, "better data", is using a different sense of the term "quality", referring more to the general excellence of the data than how accurately it represents the original.

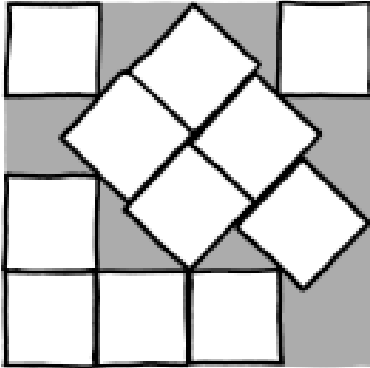
The title text uses your cat as an example of this range of losses (or, in the case of the latter reaches of the graph, gains) in the information. This is possibly a reference to Norbert Wiener's quote, "The best material model of a cat is another, or preferably the same, cat." The most lossy is an exclamation about how cute your cat is, which is ephemeral and obviously carries very little significance

in terms of actually providing specific, transferable information about your cat. The example then progresses into your cat's chip ID; presumably your cat has been microchipped, and between the last four digits (commonly used in sensitive information as an identifier without revealing the full number) or the entire chip ID, provides a still-uninformative yet slightly improved way of identifying your cat. A drawing of your cat and a photo of your cat would portray the cat reasonably well, while a clone of your cat and (of course) your actual cat would be the best way of gaining information about your cat. However, as in the actual comic, the final, most lossless (in this case, with the most gain) form of data transfer has nothing to do with your cat, but is simply Randall's better cat. This is apparently made out by Randall to be the pinnacle of cat data.

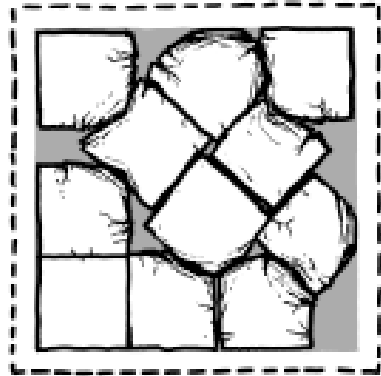
Details[\[edit\]](#)

#2740: Square Packing

February 20, 2023



PREVIOUS BEST
 $s < 3.877084$
(GENSANE, 2004)



NEW RECORD
 $s < 3.40$

I'VE SIGNIFICANTLY IMPROVED ON THE
SOLUTION TO THE $N=11$ SQUARE PACKING
PROBLEM BY USING A HYDRAULIC PRESS.

I also managed to improve the solution for $n=1$ to $s < 0.97$,
and with some upgrades I think I can hit 0.96.

Explanation

The square packing problem is a type of geometry problem. The goal is to find the smallest possible "outer square" that will fit N "inner squares" that are each 1 unit wide and 1 unit tall. In the comic $N=11$, leading to its name of "The $N=11$ Square Packing Problem," and the value ' s ' is the length of the outer square's sides. (For example, with 16 squares arrayed in a 4×4 square, ' s ' would be 4. [an image would be helpful here])

This comic spoofs a common phenomenon for some values of N : sometimes the optimal solution looks very "sloppy" to human sensibilities. The lack of a uniform grid or pattern, where some squares look to be misaligned or a lot of space looks wasted, counterintuitively leads to a smaller value for ' s ' than something more "organized" might be. ' $N=11$ ' is one such "frustrating" solution (though it should be noted, the solution depicted has not yet been proven to be optimum).

A few days before this comic's post, a web page Squares in squares gained interest on social media platforms such as Twitter and Hacker News. For many values of N , that page depicts the best known solutions, some of them known to be optimum. The one for $N=11$ (best known but not proven to be optimum) is the one Randall uses for this comic; its general arrangement was found by Walter Trump in 1979 and slightly improved by Gensane et al. in 2004.

Randall claims to have found a more efficient solution for this $N=11$ case, by physically deforming the squares involved in the best-known solution with a hydraulic press. The size of the resulting bounding square is indeed smaller, but the "solution" isn't actually one because the inner shapes have countless wrinkles and are no longer squares. Geometrical shapes in packing problems are not conventionally assumed to be a soft-body in this manner.[citation needed]

The title text mentions the same approach "improved" the solution for 1 unit square, whose optimum solution is obviously that unit square itself with $s=1$. Randall remarks that if he had "some upgrades", presumably a more powerful hydraulic press, he could get the resulting square to be even smaller.

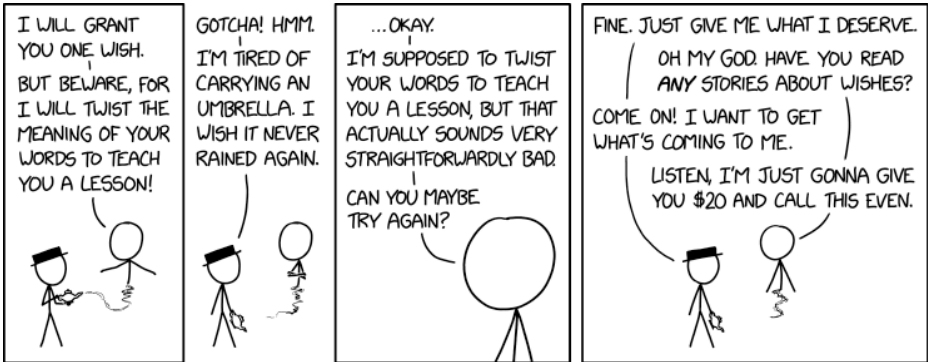
The humorous implication behind the comic and the title text is that rather than the shapes being mathematical, abstract shapes, they are actually physical squares, constructed of some extremely strong, but not completely incompressible material. It is not obvious what material that might be: even using a hydraulic press, its cross-sectional area can only be reduced to 92-94% of its original size. (The fact that the theoretical squares exist in a 2D universe in the problem statement, but here are seemingly 3D objects showing distortions in the sides facing the viewer after being presumably crushed from the top and sides in turn by the hydraulic press, is not more fully addressed.)

This is perhaps a related joke to 2706: Bendy, but now

with squares and compressed areas instead of triangles and extended lengths. Unsolved packing problems also appear to be a long-standing interest of Randall, who shows himself pondering "the most efficient packing of round-cut diamonds of uniform size" in the What If? Expensive Shoebox, with the title text "A Google search for unsolved+packing+problems very nearly got me just now."

#2741: Wish Interpretation

February 22, 2023



"I wish for everything in the world. All the people, money, trees, etc." "Are you **SURE** you--" "And I want you to put it in my house."

Explanation

In this comic Black Hat has found a lamp with a magical genie inside. This genie will only fulfill one wish (not the standard three) and warns that it will twist the wish to teach him a lesson...

In stories where wishing can come true by magical means, a common cliché is that the wisher will make a wish (for greater or lesser personal gain) but the entity who grants it will inadvertently (or 'inadvertently') fulfill the exact wording in such a way that something bad happens which the wisher clearly did not foresee. This may teach the wisher, or at least the reader of the story, an important moral lesson against greed. The wish-granter is not always represented as deliberately obtuse or malicious, but may merely be a naive and uncritical servant of the wish-granting process. A wish for money, for example, might be 'easiest' to accomplish by suddenly being the recipient of a loved-one's life insurance rather than the rather less upsetting[citation needed] scenario of finding that they possess a winning lottery ticket. In the comic, however, this genie is perfectly self-aware of the part he will play in creatively misapplying the wish, and even goes so far as to forewarn the wisher – maybe a deliberate ploy to have wishers take a moment to think and tone down their more spontaneous demands.

However, as is characteristic for him, Black Hat has no concern for the wider negative effects, and immediately

wishes for rain to no longer happen, perpetually, for the apparent trivial reason of merely saving him the need to carry an umbrella. The consequences of this drastic change to the weather (no matter by which method it is accomplished) would plainly be very bad, as Black Hat is almost certainly fully aware. The genie realizes that there is very little 'good' idea for him to twist into a bad one, and that Black Hat will be peculiarly unreceptive to being 'taught a moral lesson'. Especially compared to the utter devastation that the granted wish will cause to the rest of the non-wishing world, which the genie might be reluctant to enact.

Having persuaded his wisher to retract the original request, the genie now has to deal with two rather too open-ended, generally pessimistic requests in a similar vein. Exactly what Black Hat "deserves" is presumably subjective. That kind of phrasing sometimes arises as a false reassurance, where a person assumes they deserve something desirable, but are ultimately judged to deserve punishment. In this case, given Black Hat's flagrant immorality, he presumably doesn't deserve anything good. He's likely smart enough to realize this, but demands it anyway, and the genie seems to have enough latent sympathy to be concerned about the trouble being invited.

Undaunted, the next version of Black Hat's revised wish uses even more unambiguously perilous wording. The suggestion of "what's coming to" someone is frequently used as a threat (or menacing promise) of violence. Even taken at face value, the wish would either be meaningless

(Black Hat would receive whatever fate would have befallen him without the wish, and the genie would have effected no change), or it would be tautologous (whatever is coming to him is whatever the result of the wish is, so how is the genie to decide what that should be?). Regardless of the outcome, Black Hat is wishing for something already negative with no room for a moral twist, or something that is essentially tautological. This disheartens the genie even more, given the genie's apparent obligation to be inconveniently literal and problematic in interpreting wishes.

Clearly outclassed in his attempt to establish his ability to cause problems, or perhaps out of pity for Black Hat's self-destructive wishes, the genie gets frustrated and backtracks rapidly. He offers just \$20 (a token amount of money, especially relative to the potential gains from using a supernatural wish) to get himself out of the original formulaic deal and permanently away from having to be under Black Hat's influence.

In the title text, the wisher (possibly still Black Hat) wishes for everything in the world. This is itself a not unknown "bad wish" that would be creatively twisted into a bad consequence for the necessary narrative reasons (for example, ownership of everything in the world might come with inconvenient or even impossible responsibilities). The wish continues, however, and explicitly asks that all of this be put into their house. This is impossible for two reasons: First, everything wouldn't fit in their house unless it was made extremely dense, beyond the point of usefulness (and - depending on

density and size of Black Hat's house - could result in said "everything" turning into black hole); second, it causes an infinite recursion, since their house is something in the world, so it would have to be put inside itself. Trying to grant this wish would likely also frustrate the genie, and certainly not allow them their usual scope of a personal (and proportional) educational twist.

Black Hat has been seen experimenting with the rules for wishing before, in 1086: Eyelash Wish Log.

#2742: Island Storage

February 24, 2023



REMINDER: IF YOU'RE THE LAST ONE USING THE EARTH, PLEASE PUT THE ISLANDS AWAY WHEN YOU'RE DONE.

I always hate dragging around the larger archipelagos, but I appreciate how the Scandinavian peninsula flexes outward to create a snug pocket for Britain and Ireland.

Explanation

This is another world map vandalized[citation needed] by Randall, similarly to the bad map projection series. This time, every major island that is not considered a continent in its own right is relocated into similarly-sized swathes of sea partly enclosed by the outlines of adjacent continents. The caption implies it's Earth's intended "storage mode", where everything 'loose' is neatly packed away. A similar comic is found at 1784: Bad Map Projection: Liquid Resize.

The comic thus equates the world to a playroom in which the islands are the equivalent of scattered toys left out after playtime, or an office space where 'polite notices' ask users to replace materials, equipment, etc. in its intended storage, to leave it presentable for the next users. It indicates that the loose islands can be properly stored away in the nooks and crannies of the larger landmasses, possibly so they can be easily located when the next person comes along to play with or use them.

Though much of the apparent strange distortions of relocated islands are probably due to the relative changes in length/area/angle across differing parts of the planar-stretched map of the globe (depending upon the map projection being used), Randall is clearly also not averse to distorting the landmasses slightly to fit even the 'immobile' continental masses. He mentions in the title text that he likes to make use of the jutting outcrop of Scandinavia (though misspelled as it was in 850: World

According to Americans) by flexing it somewhat like one might do with a spring-clip, thus gripping tightly whatever islands he forces within the gap (in this instance, the British Isles and Svalbard). No-one knows what happened to the Baltic islands of Öland and Gotland though. Maybe the Irish ate them?

On 4 March 2023 the last few words of the title text were changed from the British Isles to Britain and Ireland (this may or may not have been strictly necessary).

Table of islands[edit]

New locations of selected islands that are visible on the map:

#2743: Hand Dryers

February 27, 2023



I SPENT DECADES MISTAKENLY ANNOYED AT HAND DRYER ENGINEERS,
SO NOW I'M ON A MISSION TO SAVE OTHERS FROM THE SAME FATE.

I know hand dryers have their problems, but I think for fun we should keep egging Dyson on and see if we can get them to make one where the airflow breaks the speed of sound.

Explanation

A hand dryer is an electrical device which uses air flow, typically of hot air, to dry the user's hands after they have just washed them. In the 30 or so seconds it takes to dry the hands, the user may feel as though the air coming from the hand dryer isn't actually warm, hence seeming like they "take forever to heat up."

Randall is pointing out that evaporation is an endothermic process, which is why sweating cools you down and therefore why regular fans, which actually increase the air temperature through friction, can cause a cooling effect. With hand dryers, even though the air is warm, the cooling effect makes it feel cold. The user will be able to feel the heat only after their hands are dry.

Randall has procured a small airplane, accompanied by a banner with a message explaining this phenomenon. He elaborates in the caption that he's spent dozens of years angry at the engineers of these hand dryers, as he was under the comic's erroneous impression that the air from the dryers was not actually warm. In an act of justice for hand dryer engineers everywhere, he now considers it his personal mission to explain to the public why this is actually a misconception. And indeed, it seems to be working - a person on the ground has already been enlightened by Randall.

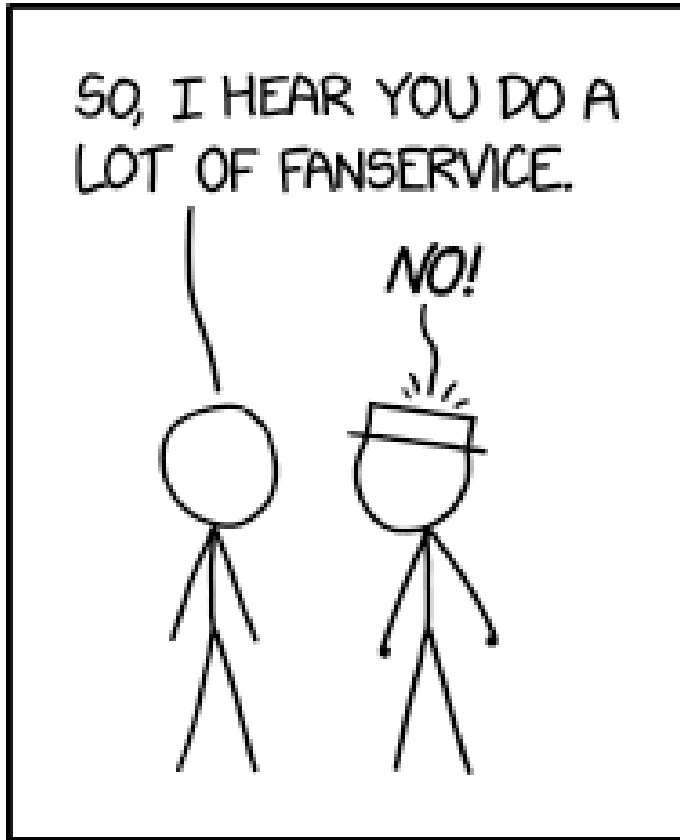
In the title text, the speed of sound is the speed of a sound wave in a given medium, usually air. Breaking the

sound barrier is often touted as a significant achievement for powered aircraft (this was first safely achieved in the 1940s, and became significantly 'easier' with the development of the jet engine). Here, Randall thinks it would be a good idea to try and get the Dyson company (a technology company known for making high-tech and expensive air-moving devices) to design a hand dryer whose airflow would exceed the sound barrier. Dyson's marketing often turns on the very high speed of the airflow produced by their motors, often many hundreds of kilometres per hour, indeed approaching the speed of sound. However, there are side effects of supersonic airflow, including sonic booms, which would make it impractical for purposes of drying hands in an enclosed area.

This comic is not the only one to involve people flying banner planes to inform people on technologically related things: see also 1965: Background Apps.

#2744: Fanservice

March 01, 2023



HOW TO ANNOY A TURBINE MAINTENANCE ENGINEER

I was eventually kicked out of my architectural engineering program because I wouldn't stop referring to HVAC as "the fandom."

Explanation

This comic is another comic on How to annoy people. It is almost identical to 2036: Edgelord, only different text, and has the same setting as 2654: Chemtrails, except there it is Ponytail that gets annoyed.

In all of these comics, modern slang terms or just commonly used words are used to describe jobs or ideas, and while the slang or word seems accurate if taken literally, it isn't normally used in that context. A graph theory Ph.D. was labeled an "edgelord", a reference to mathematical graphs having edges, trails of ant pheromones were labeled as "chemtrails", a reference to pheromones being chemicals, and scientific hypotheses were referred to as "fan theories."

This time a turbine maintenance engineer is described as doing a lot of fanservice, as in literally servicing fans (with which turbines are often inaccurately conflated). A second order of dissonance is introduced from the difference between fans and turbines, which work oppositely: fans use energy to propel a fluid, while turbines use a flowing fluid to generate energy. Randall has previously touched on wind turbines not being fans, most notably in 1378: Turbine.

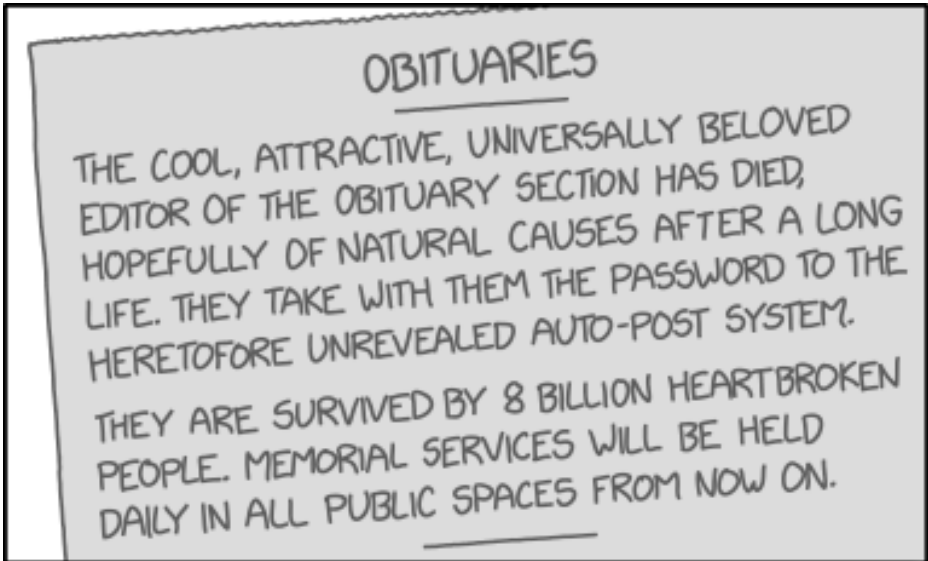
Fanservice is a term used to describe decisions made in fictional media, usually TV or film productions, that are intended to make the fans happy. The term is sometimes derogatory as it implies some degree of pandering to the

fans over finishing the story, and in such cases can be incredibly distracting. It can just mean inserting obscure details of the work's back-history, to spark gleeful recognition among the more devoted fans, but it most often refers to the inclusion of titillating scenes — the Ms. Fanservice trope where female characters routinely wear form-fitting outfits is a good example.

In the title text, Randall refers to HVAC (a term for the unified Heating, Ventilation, and Air Conditioning systems of a given building) as "the fandom." Normally, "fandom" means the group of fans of something, but here refers to a domain that uses lots of fans. Randall tells that he was thrown out of his architectural engineering program because I wouldn't stop referring to HVAC as "the fandom." This is related to the many conferences he says he has been banned from.

#2745: Obituary Editor

March 03, 2023



As the editor has reportedly defeated Death in a series of games of skill, no further obituaries are expected.

Explanation

An obituary is an article in a newspaper about a person who has recently passed away, celebrating their life. (It is distinct from a death notice, which is a paragraph, often short, usually paid, describing a person who has recently passed away. They usually offer a few words of praise and a list of surviving relatives, as well as a scheduled time for memorial services.)

Apparently, the editor of this newspaper's obituary section has just died, and they have pre-written their own obituary. This is often done for famous people, to speed the process of writing and fact-checking, but it is unusual for a not-so-famous person like this editor. In their obituary, they somewhat vainly describe themselves as cool, attractive, and universally beloved.

The following sentence reveals that the editor had set up a system, perhaps based on a Dead man's switch, to automatically post ("auto-post") their own obituary.

Obituaries often note that the deceased is survived by some close family, such as parents, a spouse, and children. This editor notes that they have been survived by 8 billion people, or the current population of the entire Earth, which is true because almost all of them are still alive and the editor isn't. However, the editor combines the two senses of what it means to survive another person, imagining that each of those 8 billion people would suffer the same heartbreak as close family

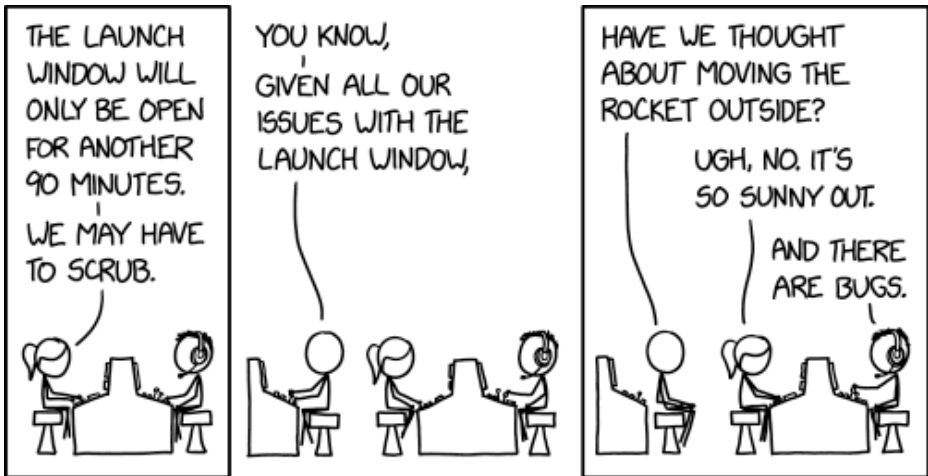
generally do.

The title text references a common trope in culture, in which a person challenges Death, often personified as the Grim Reaper, to a game of skill such as chess. The obituary editor claims that they have challenged Death to a series of games of skill and defeated Death in all of them. This victory has been so absolute that no person will ever die again, and therefore no more obituaries will ever be required. As a result, this editor's obituary will be the last one ever published, making it even more noteworthy.

Randall has referenced this trope in 393: Ultimate Game, as a tribute to Gary Gygax, the inventor of Dungeons and Dragons.

#2746: Launch Window

March 06, 2023



"Confirmed, we have to scrub." "Ugh, okay. I'll get the bucket and sponge."

Explanation

A launch window is a brief period of time in which a spacecraft can be launched from Earth's surface such that the spacecraft can reach its destination with the minimal amount (or an amount lower than a threshold of acceptance) of energy expenditure.

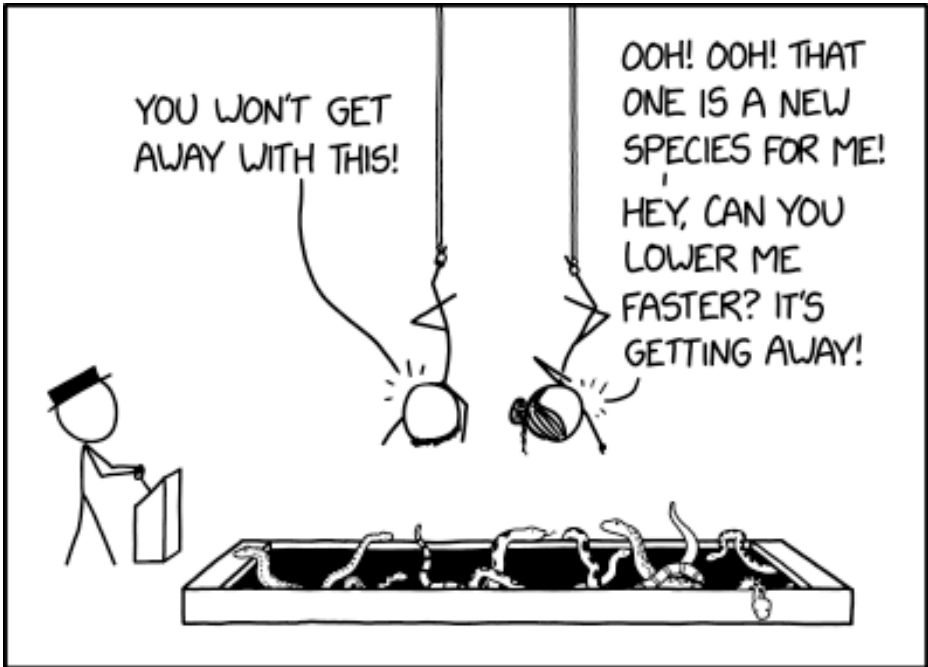
This comic takes the concept of a "launch window" in a more literal direction, implying that they have an actual physical window that is only open at certain times, and through which the rocket presumably has to be launched. Cueball, representing one of the three technicians we see working in a mission control center, suggests moving the rocket outside in order to avoid issues that arise from dealing with the window. This immediately gets pushback by the other technicians who, in stereotypical behavior of shut-ins, don't want to bother leaving their comfortable computers. Ponytail complains the outside 'is so sunny', which ironically would normally indicate good conditions that would permit a launch. Hairy also objects because it would cause them to have to deal with bugs, presumably not of the technical type which might commonly prevent a launch, but more of the living, biting kind.

The title text continues the comic's theme of taking aerospace terms literally, with a play on the two meanings of scrub. Normally, in the context of a rocket launch, this would mean to cancel the launch, but here it apparently means that some cleaning job is required,

possibly of the window in question (though how that would help them to launch the rocket through it is unclear), or possibly to deal with the aftermath of launching through the closed window.

#2747: Presents for Biologists

March 08, 2023



THERE'S A SURPRISING AMOUNT OF OVERLAP
BETWEEN "GOOD PRESENTS FOR BIOLOGISTS" AND
"THINGS VILLAINS WANT TO DO TO JAMES BOND."

A lot of these are actually non-venomous, but I can see which species you mistook them for. If you pause the crane for a sec I can give you some ID pointers for next time!

Explanation

In this strip, Black Hat is a supervillain subjecting 'James Bond' (drawn as Hairy) to a death trap. The James Bond film franchise (particularly in its early years) had a reputation for villains capturing James (often alongside a female companion) and placing him or them in overly complex death traps, rather than simply shooting them (which, of course, consistently allows Bond to engineer an escape).

In this scenario, the trap consists of slowly lowering Bond and his companion into a pit of venomous snakes. The intent, presumably, being that the very common fear of snakes, combined with a likely slow and painful death from the snakebites, would kill them in a particularly gruesome way. However, Bond's companion in this strip is Hairbun. Rather than being frightened, she's fascinated by the various species of snakes represented there, including one she hasn't seen before, and asks to be lowered faster, so she can observe it more closely before she loses sight of it.

The caption reveals that Hairbun is a biologist, and comments that many things that would be considered elaborate death traps in fiction (such as a giant pit full of different kinds of snakes), would be a good gift for a biologist.

The title text reveals that Hairbun has identified at least some of the species represented in the pit and points out

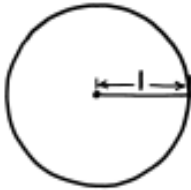
that a lot of them are non-venomous. While that might seem mildly reassuring, the way she phrases it implies that she's also identified venomous varieties in there. Moreover, she can also guess which species the villain mistook them for and offers help in correctly finding and selecting venomous species in the future. Her unprompted willingness to do this suggests that she's genuinely so enthusiastic about snakes that it overwhelms any fear for her own safety.

The scientific implications of Bond villain traps were also referenced in 123: Centrifugal Force, which also features Black Hat.

#2748: Radians are Cursed

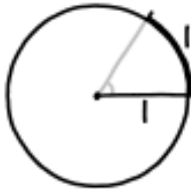
March 10, 2023

MATH FACTS



THE UNIT CIRCLE HAS
A RADIUS OF ONE

✓ NORMAL



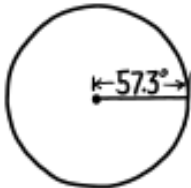
ONE RADIAN EQUALS
THE LENGTH OF A
CIRCLE'S RADIUS

✓ NORMAL



ONE RADIAN IS
57.3 DEGREES

✓ NORMAL



THE UNIT CIRCLE
HAS A RADIUS OF
57.3 DEGREES

✗ CURSED

Phil Plait once pointed out that you can calculate the total angular area of the sky this way. If the sky is a sphere with radius 57.3 degrees, then its area is $4\pi r^2 = 41,253$ square degrees. This makes dimensional

analysts SO mad, but you can't argue with results.

Explanation

This comic presents a series of Math Facts, appearing to be in a sequential order. The first fact states that the unit circle has a radius of one, which is precisely its definition. Randall labels this fact as being "normal," complete with a large green checkmark to verify this. The unit circle is typically used in abstract contexts rather than applications with a specific length unit (such as meters). For example, the trigonometric functions cosine and sine can be define the x and y coordinates of a point on the unit circle without any additional factor.

The second fact states that one radian is equal to the length of a circle's radius. This isn't actually the way that the unit is defined. Instead, radians are usually defined as the angle encompassing an arc of a circle equal in length to its radius. This comic's logic is thus somewhat erroneous. However, this fact is still labeled as also being "normal." Also, while Randall again uses the unit circle in the fact's associated diagram, any circle could theoretically be used to show the conventional definition. Under the standard definition of an angle as the ratio of the length of a circular arc to its radius, the radian is a dimensionless unit equal to 1.

A correct version of the second fact would be that a radian has the same value (1) as the radius of the unit circle. The third fact states that one radian is equal to 57.3° . This is indeed true (albeit rounded). The circumference of a circle is 2π radius-lengths, so the angle

of a complete circle is both 2π rad and 360° . Thus $1 \text{ rad} = 180/\pi^\circ$. This fact is again labeled "normal."

The fourth and final fact states that because it was determined in earlier facts that a radian is equal to the radius of the unit circle as well as 57.3° , then the radius of the unit circle must be equal to 57.3° . This is usually not how degrees are supposed to work, because they are a measure of angle, not length. Hence, this fact is labeled "cursed" by Randall, leading to the comic's title. (However, since the radian is also an angular measure, the second fact could be viewed as equally cursed.)













The title text is referring to Phil Plait's claim about the size of the sky, which was published on his blog: <http://www.badastronomy.com/bitesize/bigsky.html>. Dimensional analysis utilizes the rationale that both sides of an equation need to have the same unit. Radius typically refers to a length, which has SI units of meters. The surface area has SI units of square meters. The units of Phil Plait's "angular area" is as the title text mentions, square degrees. Thus the comic's dimensional analysts (not a profession, but instead the adherents of the mathematical technique) are said to be angered by this argument.

Randall has alluded to Plait's angular area tip previously in his own blog What If?, in a post that examined the chances of hitting various celestial objects with a laser blast aimed at random from Earth's surface.

#2749: Lymphocytes

March 13, 2023

LYMPHOCYTES AND THEIR FUNCTIONS

<p>PLASMA B CELLS</p>  <p>CHURN OUT ANTIBODIES</p>	<p>NAÏVE B CELLS</p>  <p>TRY TO STOP PATHOGENS BY ASKING NICELY</p>	<p>MEMORY B CELLS</p>  <p>VERY QUIETLY SING "MEMORY" FROM CATS AT ALL TIMES</p>	<p>REGULATORY B CELLS</p>  <p>REQUIRED BY LOCAL ORDINANCE</p>
<p>CD8+ T CELLS</p>  <p>MELEE COMBAT</p>	<p>CD4+ T CELLS</p> <p>AAAAAAAAA!</p>  <p>SCREAM AT OTHER CELLS</p>	<p>GAMMA-DELTA T CELLS</p>  <p>UNKNOWN/ CLASSIFIED</p>	<p>CDRW+ T CELLS</p>  <p>REWRITABLE, 700MB</p>
<p>DVD+R T CELLS</p>  <p>DIFFERENT FROM DVD-R, THOUGH NO ONE IS SURE HOW</p>	<p>NATURAL KILLER CELLS</p>  <p>NAMED BY THE WORLD'S COOLEST IMMUNOLOGIST</p>	<p>ILC1, ILC2, AND ILC3 CELLS</p>  <p>NAMED BY A SIGNIFICANTLY LESS COOL IMMUNOLOGIST</p>	<p>D CELLS</p>  <p>LARGER THAN C AND AA CELLS, USED IN OLD FLASHLIGHTS</p>

It's very hard to detect, but recent studies have determined that when plasma B cells are producing antibodies, they go 'pew pew pew'

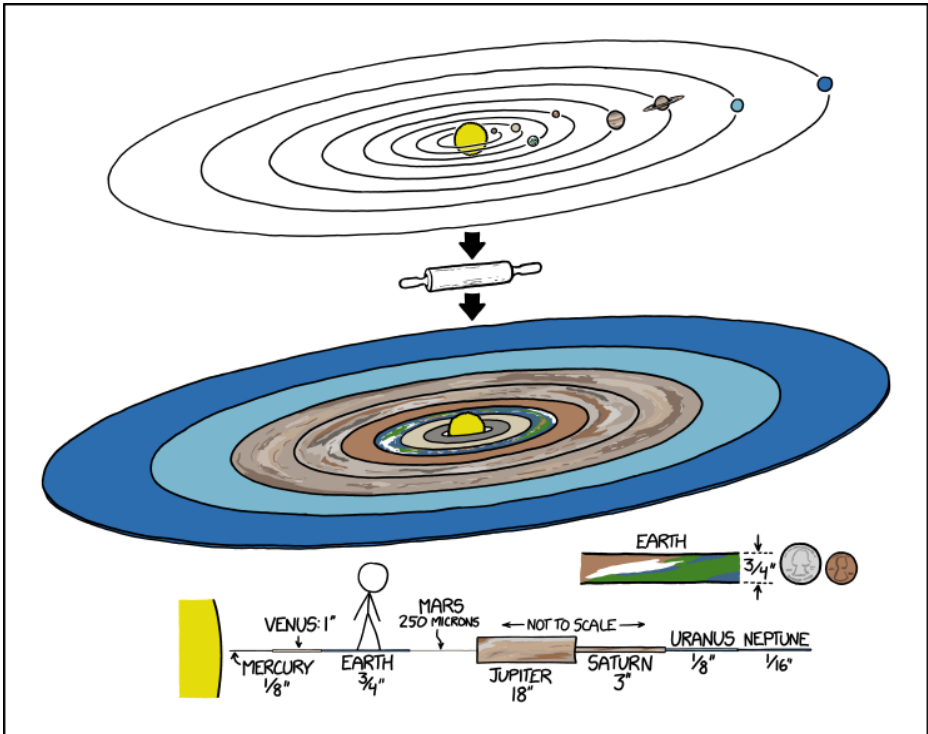
Explanation

The human body contains many different types of immune cells. This comic is a list of lymphocytes, a specific type of immune cell that is found in blood and lymph. As the comic goes on, in the style of many "informative" xkcd comics, the descriptions of the names of the cells get more and more removed from reality. Though many of the cells are real, only two descriptions are accurate, those for the plasma B cell and that of the out of context D cell. The diagrams are either uninformatively similar to each other, as an extremely generic diagram of a biological cell, or made to look somewhat like the item spoofed by the description.

The title text is possibly a reference to this recent study:
<https://pubs.acs.org/doi/10.1021/acsnano.3c00638>

#2750: Flatten the Planets

March 15, 2023



I DON'T KNOW WHY NASA KEEPS REJECTING
MY PROPOSALS TO IMPROVE THE SOLAR SYSTEM

We'll turn the asteroid belt into ball bearings to go
between different rings orbiting at different speeds.

Explanation

This comic depicts a situation where the planets in the solar system are flattened to create a ring system around the Sun. This may be inspired by the Alderson disk, a hypothetical megastructure intended to gain truly massive amounts of living space by constructing a literal disk of matter around a star. This would require several solar systems' worth of matter to do, and materials with a tensile strength beyond what is likely physically possible for any known form of matter. The planets of our solar system would not be suitable for this endeavor; alas, Randall apparently cannot comprehend why NASA is rejecting this proposal to "improve" the planets. This comic may be a follow-up to 2258: Solar System Changes.

The title text explains what would happen to the asteroid belt if this was done. He is proposing that the asteroids should be turned into ball bearings to go in between the planetary discs. There is enough matter in the asteroid belt to do this, dependent upon the size and distribution of the ball bearings used, and furthermore it implies that the discs would actually have small gaps between them. Unless the discs were made of material with impossibly high tensile strength, the whole structure would soon be torn apart by the relative forces between the inner and outer fringes of each disc trying to both 'orbit' at the rate more suited to a radial distance somewhere between the two, and crushing the bearings placed between adjacent ones. Although less so than with a single structural disc

rotating at any single given compromise rotation (or not at all).

After this comic was released, NASA issued a three-page response, claiming they do not have any records of rejecting it. In their response, they outline the various strengths and weaknesses of Randall's idea. In the end, NASA decided not to fund the project.

Strengths:

- Simplifies navigation of the Solar System
- Reduces need to study orbital dynamics
- Simplifies seasonal migration patterns as seasons no longer exist
- Would demonstrate the first real-world use of incredibly strong materials as regular materials could not withstand those strengths (NASA cites Laplace 1787 and undergraduate problem sets since then)
- Would increase the amount of ice skating, cross country skiing, and Keplerian ice-boat racing in the Outer Solar System
- Increases Solar System's visibility to galactic neighbors
- Easier visualization of the Solar System
- Removes ambiguity of comet and asteroid origins
- The night sky would be darker and there would only be night
- Would cause an actual collision with Apophis instead of a near miss

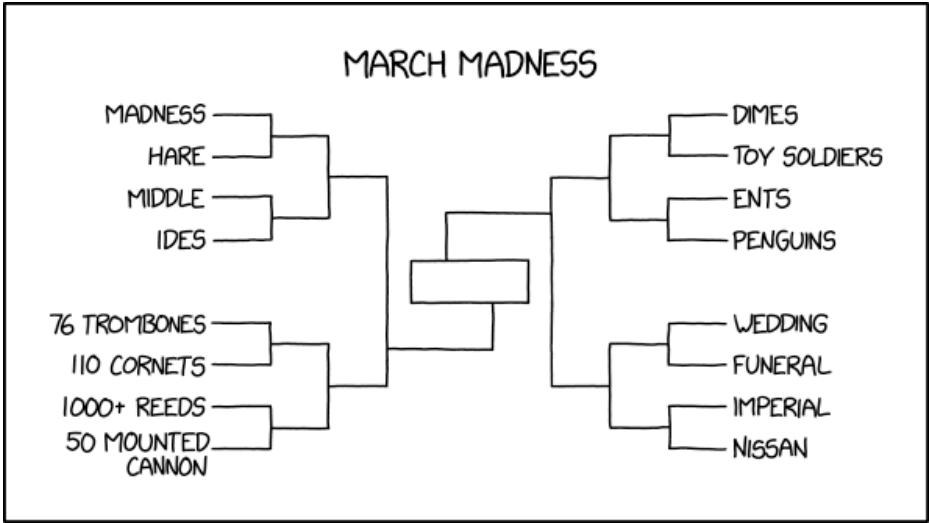
- Enables new methods of exploring the Solar System

Weaknesses:

- Would require rapid transfer of orbital assets
- Mars would be very thin and liable to being pierced by interplanetary dust particles
- Does not include Pluto
- Time scale was not sufficiently addressed
- The proposal did not address the varying density of the planets
- The proposal did not include details on the environmental impact. They said they believe this was an intentional omission
- Results in the end of all Solar eclipses
- Slides and roller coasters would be much less entertaining due to reduced gravity
- Not enough information on the thickness of Kuiper Belt and Oort Cloud
- Did not sufficiently account for Mercury heating up and expanding due to solar energy from the Sun
- May conflict with the exploration of the secrets of the Universe

#2751: March Madness

March 17, 2023



My bracket has 76 trombones led by John Philip Sousa facing off against thousands of emperor penguins led by Morgan Freeman.

Explanation

Randall has created yet another single-elimination tournament bracket. This time, everything in the bracket relates to the word March.

Upper Left:

This section has things that are named after March.

- March Madness is the (trademarked!) colloquial name given to the NCAA Division I men's basketball tournament, the season-culminating college basketball tournament played each spring in the US. It's common for college basketball fans—and even people who pay no attention to the sport for 11 months of the year—to make guesses as to how the tournament will play out by filling out brackets similar to the one shown here. They often compete against each other to see who in a group has the most accurate predictions.
- March Hare refers to the observed chaotic behavior of the European hare said to occur during its breeding season, which peaks in March in Europe. Lewis Carroll comically used the phrase as the name of a 'mad' character in *Alice's Adventures in Wonderland* as though it referred to a type of hare rather than a seasonal behavior.
- *Middlemarch, A Study of Provincial Life* is a novel by the English author George Eliot, based around the eponymous (but fictional) central English town. The name was a rather tongue-in-cheek constructed British

placename, given that a -march is associated with borderlands (such as the Welsh and Scottish Marches) and yet depicted as being set in the rather unremarkable heartlands of the middle-England of the age.

Or, more simply, it could just refer to the middle of the month of March, when March Madness takes place, as well as the Ides (see below), in a way that is rather self-referential for this particular branch of the bracket.

- The Ides of March, is the 74th day of the Roman Calendar, corresponding to March 15th, and is notorious for being the date Julius Caesar was assassinated.

Lower Left:

- All entries in this quadrant refer to the song "Seventy-Six Trombones" from the 1957 musical The Music Man. The song describes an imagined parade, particularly the large marching band leading it. ("March" can be a synonym for "parade", in this context.) The opening line of that song states that "76 trombones led the big parade, with 110 cornets close behind." The song also includes the lyrics "there were more than a thousand reeds springing up like weeds" and "there were fifty mounted cannon in the battery".

Upper Right:

All entries in this section have the words "march of" in their full names.

- March of Dimes is a charity program advocating for mothers and babies.
- "March of the Toy Soldiers" is a musical piece from Tchaikovsky's *The Nutcracker Suite*.
- The Last March of the Ents is from the *Lord of the Rings: The Two Towers*, where the ents, fictional[citation needed] treelike creatures, march against the fortress of Isengard.
- March of the Penguins is a 2005 nature documentary directed by Luc Jacquet. Originally produced in French and available in several translations, the English version has narration by actor Morgan Freeman. It is also mentioned in comic 1408: *March of the Penguins*.

Lower Right:

All entries in this section end with the word "march".

- Wedding March refers to Felix Mendelssohn's musical composition in C Major, as it's the more commonly used name. At the same time it can also be a more general description of a bridal chorus as the bride enters a wedding.
- Funeral March is a musical genre, usually in a minor key, in a slow "simple duple" metre, imitating the solemn pace of a funeral procession. An example of this is the "Funeral March of a Marionette" by Charles Gounod and Lyn Murray, used as the theme for "Alfred Hitchcock Presents."
- "The Imperial March" is a theme from *Star Wars* which often plays when characters from the Empire,

particularly large batches of storm troopers, are on screen.

- The Nissan March is a supermini car produced in Japan.

In the title text, Randall claims his bracket has 76 trombones being led by John Philip Sousa (a famous bandleader and composer who also wrote the national march of the United States; the lead character in *The Music Man* claims that he led the supposed parade) against the March of the Penguins, led by Morgan Freeman (who narrated the English release of the film).

#2752: Salt Dome

March 20, 2023



NEVER ASK A GEOLOGIST TO PASS THE SALT.

The US uses hollowed-out salt domes to store the Strategic Petroleum Reserve, and non-hollowed-out ones to store the Strategic Salt Reserve.

Explanation

This comic refers to how downwards pressure in one area of the world can cause upwards pressure in another, causing geologic structures, like salt domes, to rise up.

In the comic, Beret Guy and Ponytail are sitting at a table and eating dinner alongside Cueball, who is presumably a geologist. When asked to "pass the salt," Cueball, with his extensive knowledge of the Earth's crust and its interactions with the surface, is aware of this pressure phenomenon, and as such is stomping on his chair in order to create downward pressure on the ground beneath. This apparently works exactly as intended, as a salt dome has risen out of the floor and even begun to break through the dinner table. The caption humorously remarks that this is what will happen if you ask any geologist to "pass the salt," which conventionally means to simply hand a salt shaker or dispenser to another diner who cannot reach it. A salt shaker, presumably containing the salt intended to be passed, can be seen on their table. "The general problem" of passing salt and other condiments is discussed in comic 974: The General Problem.

Cueball mentions overburden pressure, a geological term referring to the pressure that outer layers of rock exert on inner layers. This is what usually causes the rising of salt domes; however Cueball's stomping on his chair would not produce sufficient overburden pressure to raise a salt dome.[citation needed] Interestingly, this is exactly the

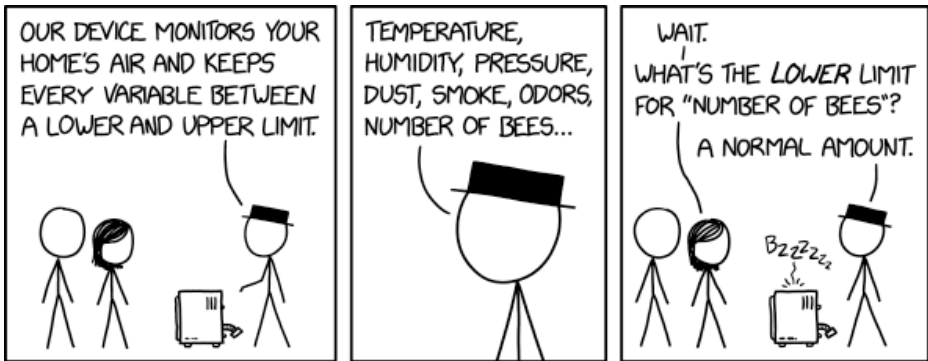
kind of strange powers Beret Guy, who is also present at the table, usually displays (see 1388: Subduction License).

The title text mentions the Strategic Petroleum Reserve, a United States government reserve of oil for use in emergencies. Randall observes the true fact that artificial caves within hollowed-out salt domes create the spaces for storage of this oil; in fact, naturally-occurring petroleum is often found under salt domes. The joke in the title text is Randall's claim that salt domes that are not yet hollow are used to store the US salt reserve. Of course this could be seen as true, but this salt is not put there by humans, but by nature, and is thus not stored there by any government. Further, the use of the term "salt dome" in the title text plays on the ambiguity between geological salt domes and the monolithic dome structures commonly used to store reserves of road salt, which also are commonly referred to as "salt domes".

Ordinary salt is available in abundance throughout the U.S. so there is no need for a national strategic salt reserve.[citation needed] However, the UK does maintain an Emergency Salt Reserve as part of a Strategic Salt Protocol to ensure highways can be salted during prolonged wintry weather, just as most communities throughout the world regularly using salt on roads stockpile it for such purposes.

#2753: Air Handler

March 22, 2023



It maintains odor levels in a normal familiar range, so if you open the windows and the air gets too fresh, it filters it through some dirty laundry samples to compensate.

Explanation

Black Hat is demonstrating an air-conditioning unit that covers a wide variety of air qualities, as opposed to a heater that just warms air, a filter that just removes dust or a dehumidifier with the main purpose of removing moisture from the air.

In many devices that manage certain atmospheric conditions in a building using one device, an operational range is usually defined, and not one number. For example, when using a heat pump, if the interior temperature drops below a preset lower limit, then the heating function would be activated. If the interior temperature rises above another preset upper limit, the cooling function would be activated. This kind of ranged function is common with humidifier/dehumidifier units as well, to create a comfortable condition not too dry nor too damp for comfort. By specifying upper and lower limits for the operation of the device in question, minor variations of the controlled value will not cause the device to rapidly turn on and off, even working against itself, improving efficiency and reducing unnecessary wear and tear on the device and the building contents.

Devices that manage temperature and humidity are often installed in buildings to improve occupant comfort. Beyond that, the listed qualities become increasingly problematic and even dangerous.

Changing the pressure of the air could lead to

unintended effects like large winds blowing through any cracks in the building.

The air handler also attempts to force the parameters of dust, smoke, odours, and number of bees into an "ideal" range. However, as opposed to being in a certain range, most people who live indoors prefer that these be minimised.[citation needed] It's also worth noting that "a normal amount" of bees varies widely depending on the situation. A typical honeybee colony contains 60,000 to 80,000 bees, and a typical swarm (bees looking to establish a new hive) is anywhere from 1,500 to 30,000. To pollinate an acre of fruiting trees typically requires a minimum of 20,000 bees, or approximately five bees per square meter.

It is not particularly usual to directly monitor the number of bees in an air-stream (usually, insect-screens are the main way to filter out any pesky creatures that might find themselves likely to be caught up in that way), and one might imagine that the upper limit should be zero, for use indoors in standard living/working spaces, but it might be technically feasible to accurately count bees (with or without distinguishing from wasps and other flying insects) and be able to allow some. But, unlike temperature or humidity, it would be rare (outside of a location used for agriculture) to have a non-zero minimum desirable quantity of bees. Even more so to then be directly equipped to upwardly correct the current value. The comic ends with Megan asking what the minimum value for bees is, and Black Hat giving an unhelpful but ominous answer that seems to confirm the

"minimum number" of bees is not zero, with his machine priming itself to release bees to get from below that minimum (it seems to have at least one trapped inside it ready to be released, judging by the buzzing sound). Even after any 'lack of' bees is dealt with, it's implied the machine can also generate smoke, dust and odours – something one would typically not miss if lacking.[citation needed]

As the title text elaborates, the machine analyses and adjusts the freshness of the air. A smart system in charge of odour-control (by spraying smell-suppressing chemicals and/or more desirable and dominant scents) could be made less wasteful by only trying to freshen the air when it detects enough necessity. But, of course, this machine also has an opposing limit. And, when the air is considered too fresh, it has a way of adding staleness/stinkiness to meet expectations with dirty laundry.

#2754: Relative Terms

March 24, 2023

QUIET		LOUD	
SMALL	BUTTERFLY	PIN DROP	POPCORN CRICKET
	MOUSE	ANT	WHISTLE SONGBIRD
	BUN (RABBIT OR PASTRY)	SNOW GLOBE	BABY
	NEWT	BOOK	FLUTE FIRE ALARM
	BALLOON		BLENDER
	HAT		FIRECRACKER
		SEWING MACHINE	
	SHARK	TREE	TUBA RIDING MOWER
	ANACONDA		CANNON AIRPLANE
	GIRAFFE	STATUE	TRAIN
BIG	WINDMILL		WATERFALL STEAM CALLIOPE
	THE MOON	NORTHERN LIGHTS	WHALE
			VOLCANO

BIG, SMALL, LOUD, AND QUIET ARE RELATIVE TERMS.
THE THING THEY'RE RELATIVE TO IS A SEWING MACHINE.

Small sewing machines are sewing machines that are smaller than a sewing machine. A sewing machine is larger than a small sewing machine, but quieter than a loud sewing machine.

Explanation

The terms "small" and "big" are used to refer to size; the terms "loud" and "quiet" are used to refer to (audial) volume. While these terms are relative, they are often used even when there is nothing obvious being compared against (e.g. "A windmill is a big thing" or "An ant is a small thing").

This comic humorously suggests that the item defined to be in the middle of all four terms ("neither small nor big; neither quiet nor loud") is a sewing machine, as a sewing machine seems (at least in comparison to the other items on the graph) to be neither particularly big nor particularly small; neither particularly quiet nor particularly loud. A standard sewing machine is roughly 60dB in volume and approximately 42" X 21", although this is for industrial machines, and those in the home (table-top electric models) would be both smaller and quieter. More antique treadle-powered sewing machines might include the treadle-table, as an integral part of its size, but could be even quieter if kept well-maintained.

As the reference point, the sewing machine is placed in the center of the chart, while a selection of other example objects are located in the four quadrants around it, based on whether they are considered to be small or big, and loud or quiet. Many of the items might appear to have been placed in the wrong quadrant for their actual attributes; locations may reflect more how Randall generally thinks of these things, as opposed to others'

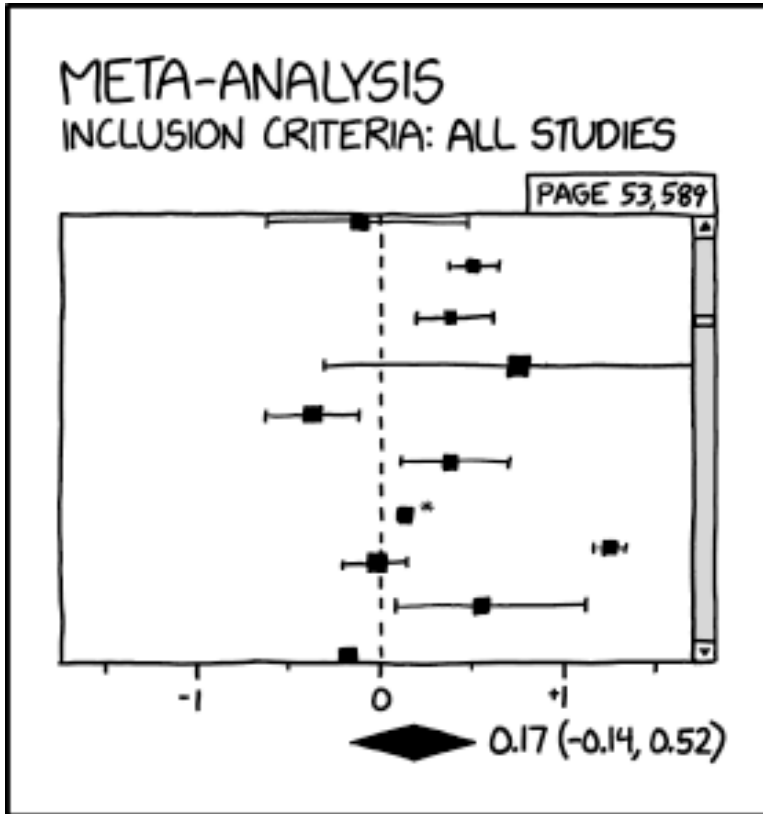
subjective ideas of their real-life relationship to a sewing machine.

Other references from everyday life that could be placed in the center include the average adult human (the perspective from which people might measure other things), a bread-bin/box (a popular comparison for size in certain situations, but doesn't fit the bill in terms of loudness), or even something like "the size of a large/small/medium-sized dog" (which highly depends upon a shared reference of which breeds are commonly encountered, and dogs might be considered too loud to be in the middle of the volume range), all things that are often encountered. A sewing machine may once have been found in many homes, but some of the comic's comedic value may arise from the relative rarity in modern times.

The title text is humorously tautological because it compares the standard against those things that are themselves defined against the standard.

#2755: Effect Size

March 27, 2023



BAD NEWS: THEY FINALLY DID A META-ANALYSIS OF ALL OF SCIENCE, AND IT TURNS OUT IT'S NOT SIGNIFICANT.

Subgroup analysis is ongoing.

Explanation

This comic outlines a meta-analysis, or more aptly THE meta-analysis, as its inclusion criteria are simply all studies.

A meta-analysis, true to its name, is a statistical analysis of statistical analyses, usually those attempting to answer a single question. Meta-analyses are intended to account for possible individual error within each study, summarizing the general results of all of its studies in order to potentially draw a useful conclusion. For a meta-analysis to be possible, there must be some measured variable in common across the included studies.

Here, the meta-analysis consists of a graph of effect sizes for what is allegedly every single study ever conducted. Accordingly, even page 53,589 of the meta-analysis is only about 1/4 of the total graph, as the scroll bar on the right is only about 1/4 of the way down; this makes the total included in the meta-analysis approximately 210,000 pages, or around 2.3 million studies. Below the graph is an estimate of the "average effect" across all of these variables, the effect normally being the relationship being analyzed by the studies within a meta-analysis, though here it seems again to be just a conglomerate of all known effects, along with a (likely) 95% confidence interval for the findings of the meta-analysis. It's absurd to analyze all studies this way, as the variables that all of those studies measure are wildly different and it makes no

sense whatsoever to average (or otherwise analyze) them together. In addition, 2.3 million scientific studies is much too small a number; a recent estimate is that about 3 million papers are published each year, and while not all of them would have a numerical hypothesis test, many others would have several such tests.

Statistical studies are produced by generating hypotheses and then testing those hypotheses. A meta-analysis of all studies would therefore include both studies where the original hypothesis turns out to be false, as well as studies where the original hypothesis is confirmed. Hypotheses that fail to be confirmed by studies are often discarded; however, these studies would still be included in this meta-analysis.

In the caption, Randall delivers the bad news: that the meta-analysis of "all of science" has finally been performed, and as it turns out, the results are not significant. Statistical significance is the degree to which the results of a sample or study are likely due to a correlation, as opposed to chance or sampling variation alone. Apparently, across the entirety of human science in the study of our universe, the study has found a lack of significance, or of a relationship between all the variables measured by all the studies ever.

The joke lies in the absurdity of the claim that "all of science" can be analyzed at all. Science is not a singular term that can be subcategorized in such a manner, but is rather hundreds of different fields of study, many of which have little or no overlap. Doing a meta-analysis of

geology and philosophy, for example, would be patently ridiculous, so the 53,589 (or 210,000) page study is comical in its very existence, much less conclusion. In addition the comic conflates two meanings of "significant": the statistical meaning, and the more everyday meaning of importance or noteworthiness.

Additionally to the absurdity, one can see the whole joke as an instance of the Liar paradox: if one considers that the conclusion of the meta-analysis is that "science" is statistically unable to provide information on the truth of a statement, then the meta-analysis itself (in it has been made following the general principles of rigor and methods of "science") is subject to its conclusion. Hence, the conclusion of the meta-analysis might have nothing to do with the truth, and "science" might well be significant after all. But if it is, then the present meta-analysis should be considered significant as well and one should believe its conclusion, etc.

In the title text, Randall reports that subgroup analysis is ongoing. The joke here is that since all scientific studies are subsets of the overall meta-analysis, every field of scientific endeavor can be separately assessed by constraining the subgroup to include only studies in that field. Hence the subgroup analysis could be considered to include analyses of every individual area or question that scientists have made subject to statistical studies. Again, analyzing any subgroup would lump together studies that measured very different things and hence would still be meaningless.

XKCD has previously considered the topic of subgroup analyses around the important issue of jelly beans. Subgroup analyses may be used as data dredging or p-hacking in order to identify anything that is "significant" and thus publishable.

#2756: Qualifications

March 29, 2023



'So how **DID** you go from working at the employment records office to becoming president of MIT and CEO of IBM?' 'I guess I just have an eye for opportunities.'

Explanation

Black Hat is being interviewed for some unidentified position. From the conversation, it seems clear that he has used some prior access to the employment records at the employment record office he worked at to fraudulently manufacture a history of having worked there for 600 years. There are some institutions that are extant today with over 600 years of history, but, with the exception of some arms of the Catholic Church, none of their individual offices or departments have existed for that long; also, human lifespans rarely exceed 100 years, never mind 600.[citation needed] He also claims an additional pair of prestigious jobs in the title text, but it is unclear whether these 'facts' were entirely due to false records or, knowing Black Hat's other interviews, briefly true but only as a result of false representation/underhanded actions.

His interviewers, Cueball and Hairbun, are not entirely unaware of the implausibility, but Hairbun, at least, seems content to have just verified the validity of the claim. The 'validation' arises from the clearly tainted information source, given the whole chain of supporting evidence that may have been falsified. This is essentially a more elaborate version of Black Hat's ploy in another interview 17 years prior.

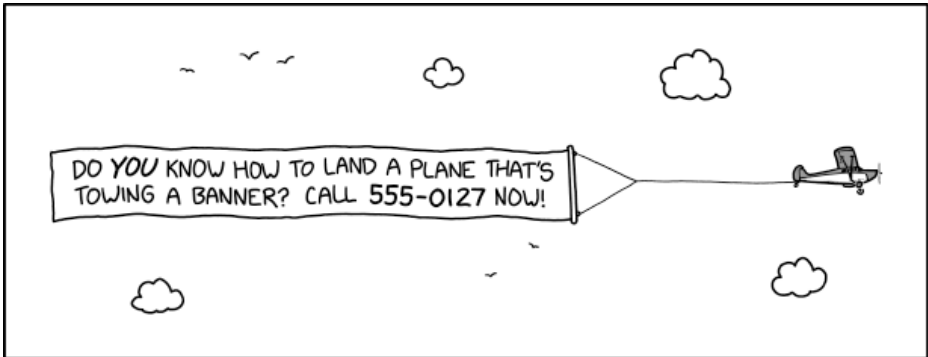
Employers often encounter résumés that have implausibly padded experience claims. Most applicants try not to be this implausible, and few employers are so

credulous as to take self-supporting lies at face value.

The title text suggests that Black Hat changed the records during his position at the employment records office to make it look like he was president of MIT and CEO of IBM.

#2757: Towed Message

March 31, 2023



"Hi, what you do is fly over a designated zone and detach the--" "WE'RE SORRY, THE MOBILE CUSTOMER YOU ARE TRYING TO REACH IS OUT OF SERVICE"

Explanation

In this comic, an aircraft is towing a banner. These aircraft do not take off or land with the banner in tow, but instead have a hook and release mechanism to add and drop the banner in flight. The banner could be interpreted as a recruitment ad by an aerial advertising company looking for additional pilots. But the humorous interpretation is that the banner is a distress signal – the pilot of the aircraft doesn't know how to land, and is hoping that someone will see the banner and give assistance. This makes the banner self-referential, because the presence of the banner (which makes landing difficult) is the very reason for displaying the banner. It is paradoxical, because printing and deploying the banner requires planning,[citation needed] and if the pilot had anticipated that they would need assistance to land with a banner, they could have simply chosen not to deploy a banner in the first place.

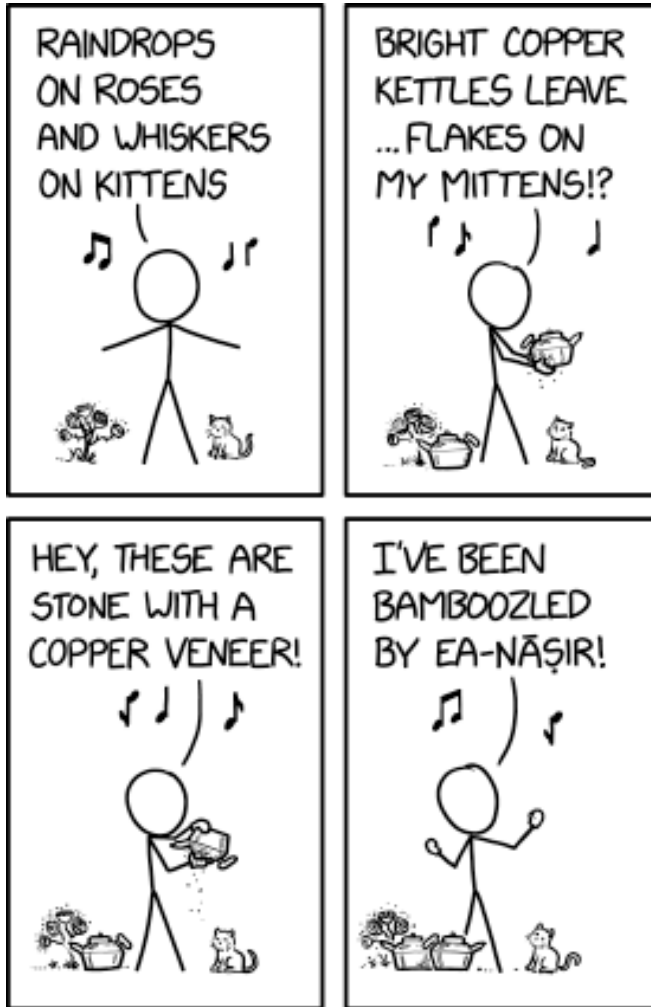
The aircraft in the illustration is similar to a Piper J-3 Cub, which is popular for tasks such as towed banners for its low operating cost and good performance at low airspeed.

The title text features a caller who dials the "555" phone number from the banner (see Trivia) and starts to explain the correct method for landing (detach the banner over a designated empty location then land the plane regularly), but the call is disconnected halfway through. Presumably the number is that of the pilot's cellphone. The call could

have disconnected because the aircraft moved out of range of the cell site the phone was connected to and the phone failed to automatically connect to an adjacent cell; or possibly the cell network detected the call on multiple sites due to the phone's altitude and disconnected it from the network; or the plane crashed and the phone was destroyed on impact.

#2758: My Favorite Things

April 03, 2023



When an Ur guy / sells Nanni things / but the copper's bad,
/ He simply records his complaint for all time / "I got a bad
deal / I'm maaaaaad"

Explanation

Cueball begins singing "My Favorite Things" from The Sound of Music. But, during the second line, instead of continuing with the actual lyrics, he sings that the copper from his kettles is flaking off. He then realizes that he's been scammed, and curses the name of Ea-nāšir to the heavens.

This references the complaint tablet to Ea-nāšir, an archeological artifact containing the earliest known written business complaint, found in the ancient city of Ur and dated to around 1750 BCE. Ea-nāšir was a Sumerian copper merchant, and the writer of the complaint alleged Ea-nāšir had scammed him by offering sub-quality copper (echoed by Cueball's counterfeit copper kettle), refused to provide a refund and had fallen short of expectations in other ways. Additional correspondence was discovered, to indicate that this was not their only dissatisfied customer. Ea-nāšir was also referenced in 2650: Deepfakes.

In recent years, this complaint tablet has become an internet meme, deriving humor from the fact that so many of its themes (business fraud, poor customer service, a hapless consumer trying to get his money back) are still very much applicable today, nearly 4,000 years later. One such meme references a 2021 fraud case in Turkey, in which a trader was charged 36 million USD for a shipment of copper ingots, which turned out to be stones, painted with a veneer to make them look like

copper. This line about "stone with a copper veneer" likely refers to this case.

The title text continues the parody for the chorus of the song, for which the original is "When the dog bites/When the bee stings/When I'm feeling sad/I simply remember my favorite things/And then I don't feel/So bad". "Ur guy" references Ēa-nāṣir, while Nanni is the name of the customer who wrote the complaint.

#2759: Easily Confused Acronyms

April 05, 2023

EASILY-CONFUSED ACRONYMS CHEAT SHEET

LASER

LIGHT AMPLIFICATION BY THE STIMULATED EMISSION OF RADIATION

MASER

MICROWAVE AMPLIFICATION BY THE STIMULATED EMISSION OF RADIATION

SONAR

SOUND OMPLIFICATION BY THE NIMULATED AMISSION OF RADIATION

RADAR

RADIO AMPLIFICATION BY THE DIMULATED AMISSION OF RADIATION

LIDAR

LIGHT IMPLIFICATION BY THE DIMULATED AMISSION OF RADIATION

'Lever' was originally an acronym for Load Emplification by the Vimulated Emission of Radiation.

Explanation

In this comic, Randall compared the acronym "laser" with various other five-letter acronyms.

He first explained "laser" correctly. Then "maser", which is a type of laser and changes only one word in the acronym, he also explains correctly. Although in both cases he includes the definite article into the expanded phrase ("by the", instead of just the more usual "by"), to the same ultimate meaning and with short words that are traditionally not so often used in the initialisms (like "of" is not, here, also) and thus allows them to be more pronounceable acronyms that have become words in their own right rather than more awkward initialisms.

He then makes entries for "sonar," "radar," and "lidar" (and "lever" in the title text), and claiming they are all just variations of "laser"/"maser." Randall twists the acronyms as much as possible to force them to sound like they are also based on "amplification by stimulated emission of radiation" even though none of these technologies, besides lidar, use stimulated emission of radiation to amplify their output. The replacement first word is correct for these acronyms, but the other words formed from changing the first letter are nonsense.

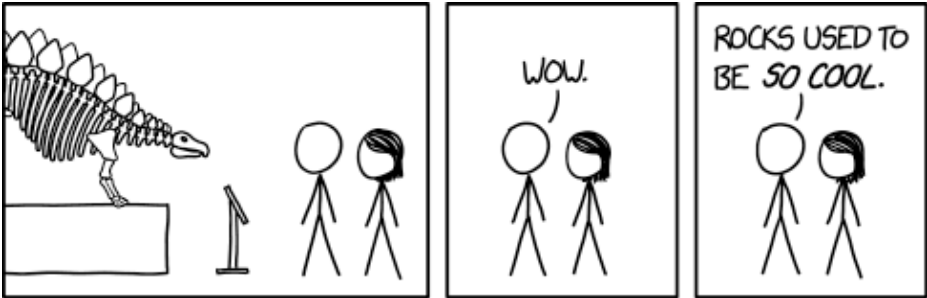
Laser and maser are true-to-life acronyms. The remaining three acronyms' true expansions are as given in the table. The false definitions suppose that all of the acronyms simply follow the same model as the first two correct

ones, and swap out the necessary letters to fit in a square-peg-round-hole manner. Note that the latter three in the table each include the second letter from their first word, for their partly-syllabic abbreviation as derived from their true phrase of origin.

The title text extends this to the five-letter word "lever". This is an ordinary word, not a commonly used acronym. Levers have been used since time immemorial (even animals have been known to use them), and predates high-tech uses of radiation by millennia (it's one of the simple machines that Archimedes studied in Ancient Greece). Etymonline traces the origin of the word to the year 1300, from the French "levier", which shares the same definition.

#2760: Paleontology Museum

April 07, 2023



Nowadays the only ones left that do anything are turtles.

Explanation

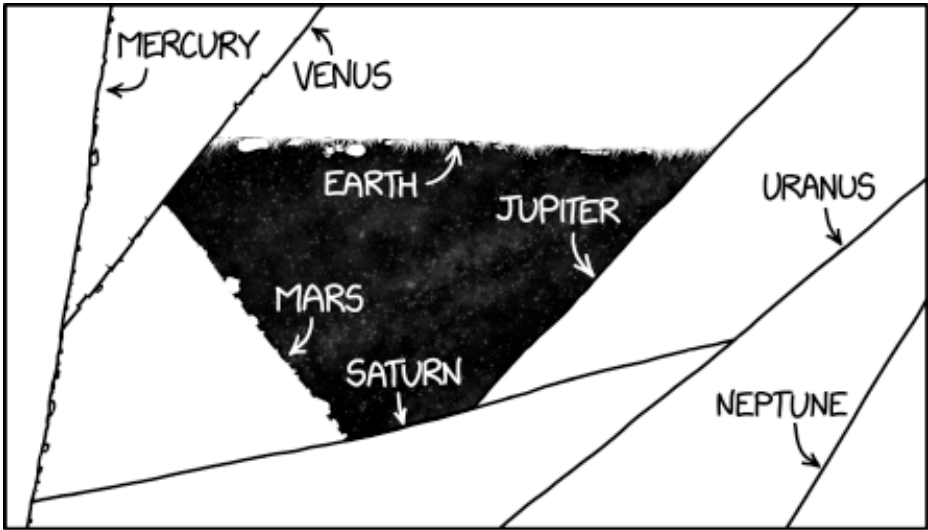
In this comic, Cueball and Megan are at a paleontology museum and are looking at the fossilized skeleton of a Stegosaurus.

Dinosaurs encompassed a wide variety of species that would be amazing to see alive today, including T. rex, Stegosaurus, Velociraptor, etc.[citation needed] Cueball is remarking that the "bones" they are looking at are now actually rock, and that 'rocks' then were way cooler (e.g. inside a dinosaur) than modern rocks. He may be under the impression that dinosaurs looked like their skeletons and therefore, were "rocks" that could walk, or perhaps just that their skeletons were actually made of rock, making those 'rocks' more cool than our modern inanimate ones.

The title text suggests that turtles are a form of animate rock. This could be interpreted in two ways. In the first interpretation, you could say that their hard shells make them seem like rocks that are able to move on their own. This gives the latest approximation to modern "rocks" that do more or look cooler than just plain old rocks. In the second interpretation, the text could be generalizing the idea of bone-based armor as "rocks" to other animals. This would include other armored animals like armadillos and pangolins. Extending it beyond bone-based to any hard outer construction could encompass many other life forms - for example, shellfish and corals.

#2761: 1-to-1 Scale

April 10, 2023



THE SOLAR SYSTEM'S PLANETS AT 1:1 SCALE

There's a version that shows the planets with no cropping, but it's hard to find a display that supports it.

Explanation

This comic is implied to be a part of a huge diagram that shows each of the eight planets at real size (as seen by the ant on Earth's surface). Each planet is represented by a circle thousands of kilometers in diameter. However, the planets have been awkwardly placed in an extremely tight circle, so that all eight planets touch (or nearly touch) a tiny central area of "space" a few inches large. This comic shows a fraction of this diagram, cropped so that we see this area of "space" and a little of the edge of each planet intentionally arranged next to it.

The joke of this comic appears to be that when planets are indeed displayed at a 1:1 scale, it is almost impossible to tell their relative sizes, even when the image technically shows (part of) each of the planets

The reason why each planet's circular border appears straight is because it's such a small area of each planet: you're only seeing a couple of square inches of the surface of each of the planets, and even though they are all round, the curvature would be imperceptible on this scale. The four gas giants are completely smooth, whereas the four rocky planets display features, most notably on Earth where grass and an ant are visible.

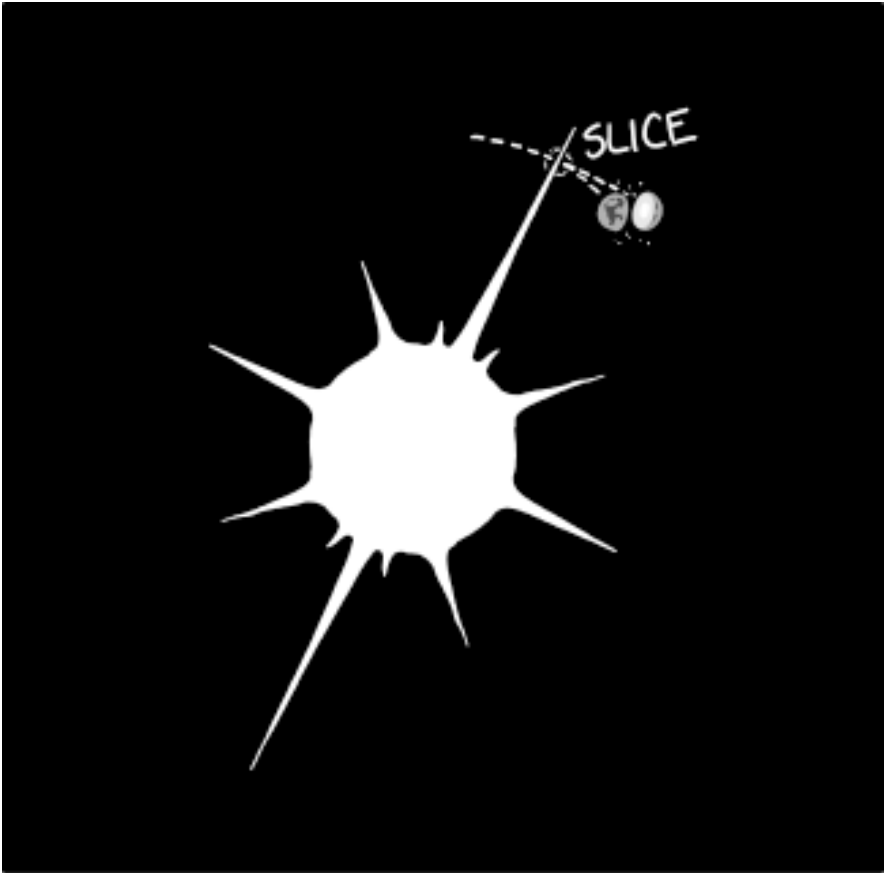
That it cannot have been an image of the real planets aligning is clear, as Mercury can be shown to be in front of Jupiter (implying that the latter is in the part of its orbit on the far side of the Sun from the viewer), yet

Jupiter obscures Earth (which necessitates that it be in the arc of orbit nearest any given observer). In other words, there is no possible real alignment of the planets in which Jupiter passes between Mercury and Earth. In the title text it is made clear that this is just a small part of a larger drawing, so this is not an image taken from far away – they are only placed this way for scale.

The title text remarks that it is hard to find a display that supports a version of the image without cropping. This is because a true 1:1 scale image showing all of the planets would be at least as big as the largest one, Jupiter – far larger than any monitor or display currently available[citation needed] – or perhaps even big enough to hold Saturn's rings, in whatever orientation they lie. Furthermore, the amount of video memory that a graphics card would need to have in order to output at anywhere near the same DPI to such a display, even as a 1-bit-per-pixel-image (i.e., all pixels are either black or white), is well beyond the capabilities of any graphic card that existed at the time of publication.[citation needed]

#2762: Diffraction Spikes

April 12, 2023



BAD NEWS FOR EXOPLANETS: IT TURNS
OUT THOSE DIFFRACTION SPIKES ARE REAL.

Even if a planet is lucky enough to have a stable orbit that weaves between the spikes, the seasons get weird whenever it passes close to them.

Explanation

Diffraction spikes are visual artifacts that appear to extend from light sources, mostly when viewed through a reflector telescope. In telescopes, they are often caused by the support struts of the secondary mirror in the telescope. They've become especially well known lately because they're quite prominent in images from the James Webb Space Telescope; its bigger spikes are due to the edges of the hexagonal mirror sections, not the struts.

The comic feigns that these artifacts are real spikes of stellar matter extending from the stars being viewed. The spikes have sufficient energy and coherence to slice planets that intersect them, rather than merely bludgeon or vaporize them. Additionally, they appear to nullify gravity - preventing the halves from recombining and allowing them to maintain their shape.

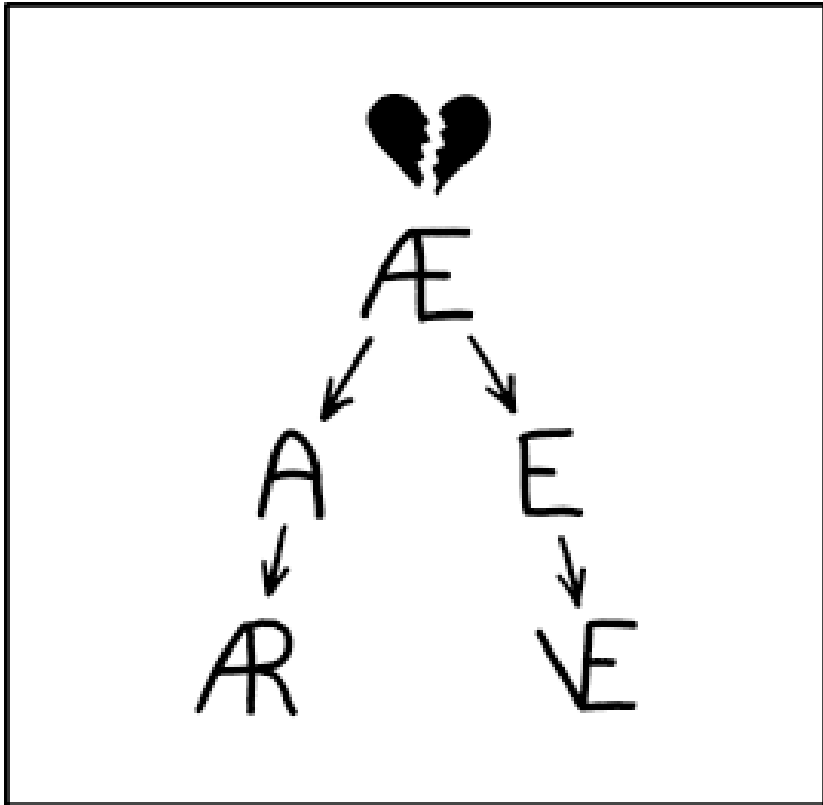
The title text suggests that a planet would have to be particularly lucky to avoid encountering one of these spikes during its lifetime. This would make our own solar system exceptionally fortunate, given the number of planetary bodies that remain whole, though it could perhaps serve as an explanation for the Asteroid belt, being remnants of formerly destroyed planets.

The title text also claims that the spikes produce sufficient light and heat to disrupt seasonal (and perhaps even diurnal) patterns on planets that come close enough to them, but this is not something we experience on

Earth.[citation needed]

#2763: Linguistics Gossip

April 14, 2023



HOT LINGUISTICS GOSSIP: THE A AND E
FROM Æ HAVE BROKEN UP AND ARE
NOW MARRIED TO OTHER LETTERS.

The E's wedding invitation definitely used the word LOVE
more times than was strictly necessary.

Explanation

Æ (pronounced "ash") is a letter formed from a ligature of A and E. Depending on the language, it can be pronounced as a diphthong /æ/ (Classical Latin), as an /ɛ/ sound like in "bet" (Old Norse, later forms of Latin), as an /eɪ/ like in "oy vey", as an /aɪ/ like in "aye-aye", or as an /æ/ like in "cat" (Danish, Norwegian, Ænglisc, and in the International Phonetic Alphabet).

The comic personifies the letters "A" and "E", imagining that the character Æ represents a romantic relationship between the two. It then imagines a situation in which the two letters end the relationship and eventually marry other letters, giving rise to two new ligatures (A with R and E with V).

The title text continues with the idea of personified letters with E's wedding invitation. In the comic, E's new relationship appears to be with the letter "V" as implied with the statement with E's wedding invitation repeatedly using the word "LOVE", which would spawn many chances to use a V+E ligature.

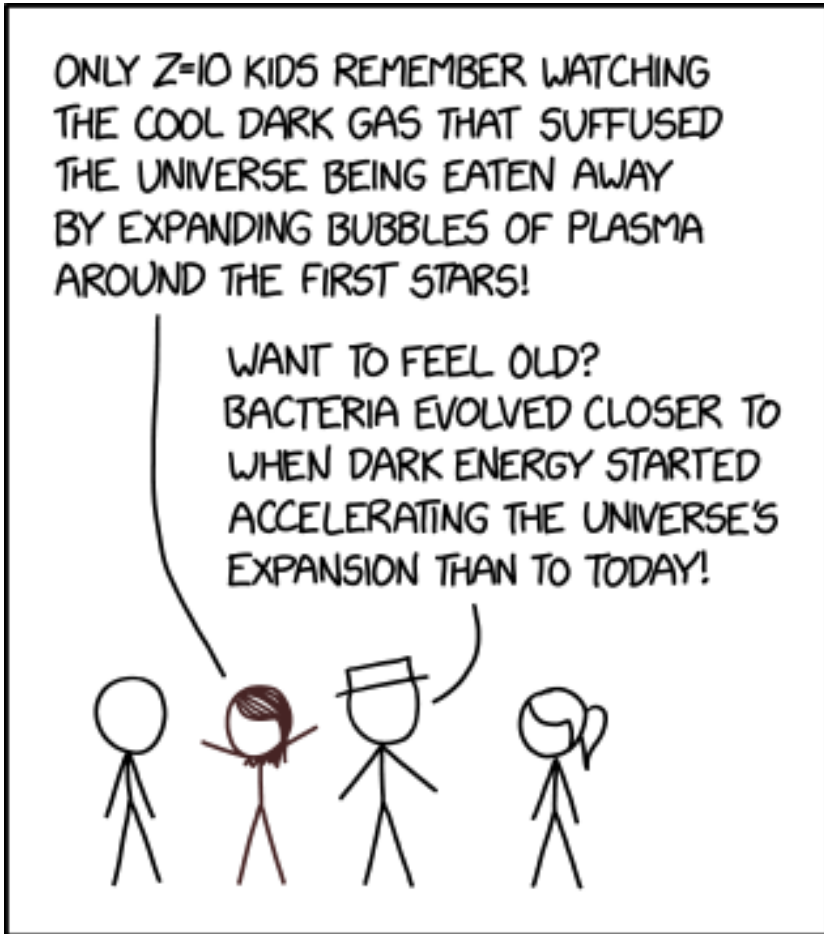
The joke in the title text is about people who brag too much about their relationships. Even though a wedding is a celebration of "LOVE", the joke is that V and E are so proud of their newfound relationship that they show off their combined ligature at every possible opportunity. From the perspective of the person who wrote the title text, the overuse of this gimmick made it feel annoyingly

repetitive instead of cute and witty.

The ash symbol is also mentioned in 1962: Generations.

#2764: Cosmological Nostalgia Content

April 17, 2023



COSMOLOGICAL NOSTALGIA CONTENT


Later renouncing clickbait, Einstein called his inclusion of cosmological content in general relativity the biggest blunder of his career.

Explanation

The title of this comic is a combination of "cosmological constant" (an astrophysics term related to dark energy and to the accelerated expansion of the universe) and "nostalgia content" (clickbait marketing aimed at a specific age group referencing pop culture from their youth). The canonical examples of nostalgia content are "Only 90s Kids Remember..." and "Feel Old yet?", and this has also formed the basis for several XKCD comics. Some people of relatively advanced years like to make comparisons to others in their age group of where events that they remember fit into history; e.g., "The first moon landing was closer to the end of World War I than to today."

In cosmology, z is the symbol for redshift, the effect whereby photons traveling from an object that is moving away from the observer exhibit an increase in wavelength, resulting in their color shifting towards the red end of the spectrum, and the variable z quantifies this amount of shift. Due to the expansion of the universe, objects that are further away from us appear to be moving away from us at a faster velocity, resulting in higher redshift. As light has finite velocity, it takes a longer time for light from faraway objects to arrive at the observer. So the light observed at the present must have been emitted by the faraway object further back in time. In this sense, after assuming a cosmological model, redshift and cosmic time can be put in a one-to-one relation and are often used interchangeably by

astronomers. Redshift $z = 10$ would correspond to about 500 million years after the universe was formed, or almost 13 billion years ago. Megan is stating that only people that were born at that time ($z = 10$) can remember when the first stars were still forming. At redshift $z = 10$ the matter filling the universe was mostly constituted of neutral hydrogen gas, referred by Megan as "cold" (it had a temperature of about 300 K) and "dark" (there were no light sources in the universe before the first stars formed. This epoch is indeed called the cosmic dark ages). The ultraviolet light emitted by the first stars started ionizing the hydrogen around them in expanding hot plasma bubbles. This process (called reionization) had probably already begun at $z = 10$, but was really completed only at about $z = 6$, when the intergalactic hydrogen was completely ionized, as it continues to be at the present day.

Megan also has a red tint (she is drawn in the color #462424, a very dark red; here is a comparison of #462424 and black: , indicating that she is one such $z = 10$ kid, because her image is red-shifted, in the literal sense. The irony is that even if she were actually born 13 billion years ago (which would be absurd,[citation needed]) her image would not appear red-shifted to us now. She would only appear redshifted to a far away observer looking at the young Megan wandering about the primordial cold dark gas.

White Hat, meanwhile, is referencing the fact that the universe has three eras: radiation dominated, matter dominated and dark energy dominated. As the universe

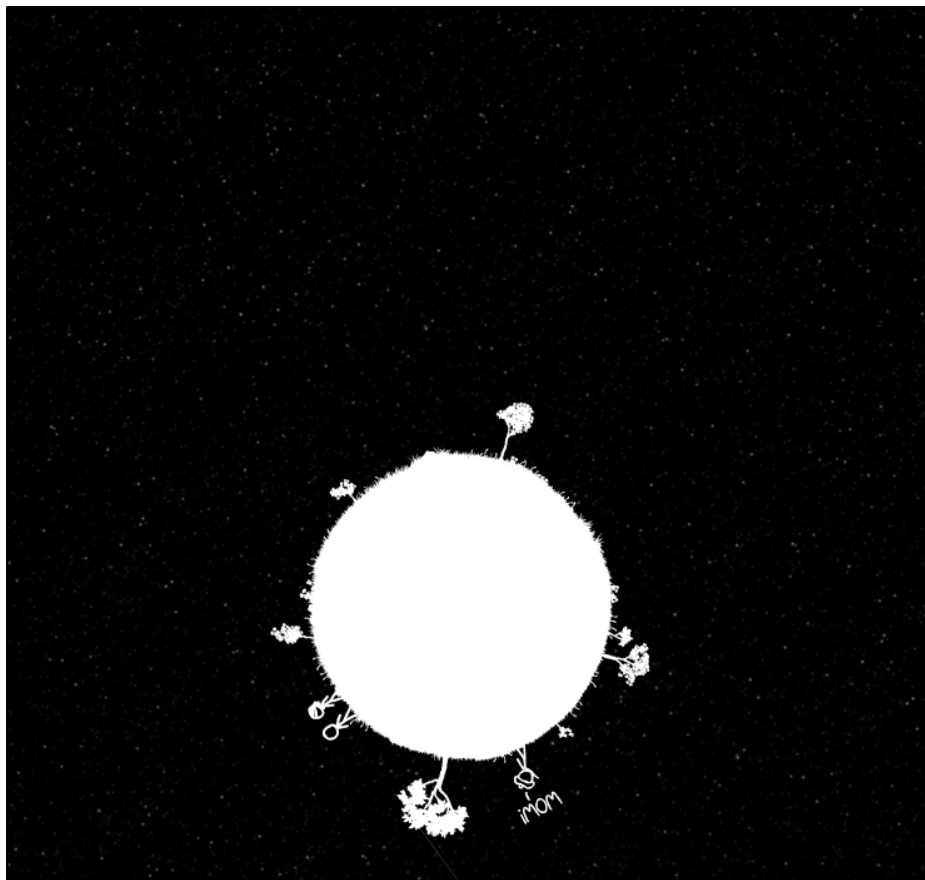
expands, the density of radiation and matter decreases due to their dilution, causing the universe, which first started off being dominated by radiation, to then become dominated by matter, then by dark energy (which is thought to not dilute as the universe expands). The dark energy dominated era, which is when "dark energy started accelerating the universe's expansion" started around 5 billion years ago, whilst bacteria evolved around 3 billion years ago, meaning that they evolved closer to dark energy domination than to today.

The title and title text play with the similarity in sound between 'content' and 'constant', segueing between web(page) content and cosmological constant.

The title text refers to Einstein's inclusion of the cosmological constant to his theory of general relativity in order to attain a static model of the universe, which he later removed, reportedly referring to it as his "biggest blunder". Cosmological constant has, today, been generally accepted as a part of the current cosmological model, relating to the concept of dark energy. It is a pun on content and constant. The title text makes the claim that Einstein actually had cosmological content, which he used to clickbait, and he removed it to renounce clickbait.

#2765: Escape Speed

April 19, 2023



Gotta go fast

Explanation

This is the 13th April fools' comic released by Randall, but 18 days late, see the trivia section below. The previous April fools' comic was 2601: Instructions, which was released on Friday, April 1st, 2022. The next became 2916: Machine released on Friday April 5th, 2024 (a regular release day, but 4 days late, even though April 1st was a Monday, also a regular release day).

This interactive comic is similar to 2712: Gravity, which celebrated the release of What If? 2, as you can visit different planets. Your fuel runs out and recharges slowly over time or instantly whenever you land. Like in Gravity, there is no "universal" point of view: the bottom of the window, "down", is oriented towards the object exerting the most gravity upon the player.

You begin on the Starting Planet, near Origin. To escape Origin's gravitational force, gain enough momentum by swinging a few times inside the large hidden tunnel that goes from the rollercoaster to the opposing side of the planet. However, note that it is possible to escape Origin's gravitational pull by maneuvering the spacecraft counterclockwise around the Starting Planet, accelerating tangential to the surface above the figure yelling "WOW!". To help you find other planets there are also many small circles surrounding the spaceship indicating the locations of nearby or distant planets depending on how transparent these points are. Collecting circles with a star outline will improve the

performance of the spaceship, such as by making the engine more efficient or increasing the rate at which the fuel recharges, and sometimes make you find a new item. Collecting small grey circles will instead just make you find an item, such as a rock with neat stripes, a cool bug, and a pretty leaf.

Most planets and celestial objects are inside of a large Crystal Sphere in which there is a visible navigable crack. Halfway through the crack, gravity gets increasingly stronger as the spaceship feels the gravitational force of the parts of the Crystal Sphere it is leaving behind. Above the crack in the Crystal Sphere, there is the Star Destroyer from 1608: Hoverboard, and on the opposite side of the crack, there is a huge part of the world in 1110: Click and Drag in the form of a round planet.

The title of the comic is likely a reference to the 1996 computer game *Escape Velocity*, which also featured a 2D map dotted with planets. The title text says, "Gotta go fast.", a reference to Sonic the Hedgehog's catchphrase, and the point of the game: getting able to go faster to escape larger and larger planets and leave the Crystal Sphere.

The Hyperdrive[edit]

The Hyperdrive is a powerful upgrade to the spaceship that massively boosts your thrusters. It is found at the center of the Boston Planet and is needed to explore the planets outside the Crystal Sphere and to escape from the black hole inside the Subway Planet. It can only be unlocked after deactivating the

MIT Cloaking Device on the Subway Planet and collecting three of the four subway tokens found at different "Bostons". Subway tokens are circles with a T outline, and they have a distinct color: "blue", "red", "green", and "orange", the four colors of Boston's subway system. The blue token on the Boston Planet is not strictly necessary to get the Hyperdrive, although it is the easiest to obtain. Note that getting it will require several other upgrades first, so it shouldn't be your first objective. See the table below for other ways to progress in the game.

Here's how to get the Hyperdrive:

Extra Escape Speed pages[edit]

Since this comic is so big and complicated, extra pages have been created to include much more information than is wished for on this main page. These pages are listed here for convenience, but they are also listed in the relevant sections below:

- 2765: Escape Speed/Transcript - The full transcript of the entire comic, as if you played the game can be found here. It is linked from the Transcript section.
- 2765: Escape Speed/The whole image - A collection of different compilations of the whole Image.
- 2765: Escape Speed/Screen-shots - Can be linked from several sections
- 2765: Escape Speed/Tables - Tables used for explanation can be put on this page.

Celestial Bodies and Collectable Items[edit]

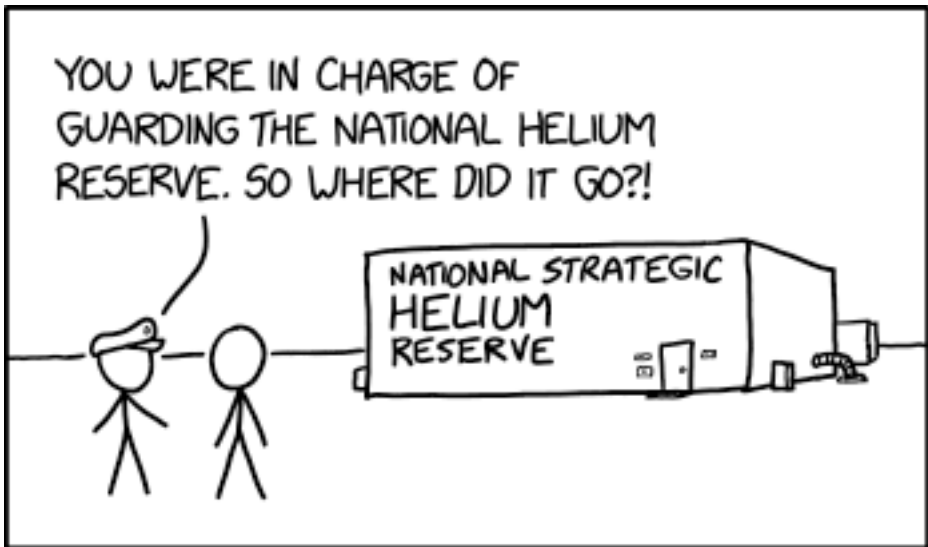
This is a table of all celestial bodies and items, in descending order of planet size (the Starting Planet, Origin, and the Hollow Planet

are at the top for their relevance). Collectable items and messages are found in the "You found...", "Upgrades", "Messages" and "Subway tokens" columns. For more detailed and in-depth tables and lists, see here. Here are some other useful resources:

- A map of the entire universe created by the community can be found here
- Screenshots of the entire world, planets, and celestial bodies made using this map can be found here
- A spreadsheet of all items and messages from the game's source code can be found here
- A spreadsheet of coordinates for all celestial bodies from the game's source code can be found here

#2766: Helium Reserve

April 21, 2023



UNFORTUNATELY, THERE'S NO GOOD WAY FOR
ME TO ANSWER THIS QUESTION OUT LOUD.

The government has been trying to sell off the Federal Helium Reserve for a few years now, but the sale has been on hold while they try to figure out how to explain this situation to buyers.

Explanation

The Strategic National Helium Reserve is a reserve of helium in the United States, which holds more than 1 billion cubic meters of helium. This reserve was established by the US Government because helium has a number of critical scientific and industrial applications, and it was considered important to ensure that those needs could always be supplied.

In addition to the scientific uses, helium is also used and sold for more frivolous applications. One of the most well-known is to fill party balloons. Since helium is much lighter than air, balloons filled with it will float. Additionally, because sound propagates differently through helium than through air, inhaling some of the gas will cause a person's voice to sound much higher. The novelty of this phenomenon has long resulted in people inhaling helium from balloons in order to hear their voices change.

Apparently, in this comic, Cueball was hired to manage the Reserve, and apparently lost or used all of the helium. The fact that he can't answer the question "out loud" implies that he inhaled all of the helium to make his voice change, meaning that even answering the question would reveal what he'd been doing.

The notion of one person inhaling the entire helium reserve is, of course, a ludicrous exaggeration (not to mention the fact that inhaling helium deprives a person

of oxygen, and inhaling that much would put them at serious risk). The joke, though, is that Cueball was having so much fun inhaling the helium, he simply couldn't stop until he'd used it all up.

It is worth noting that, due to rising prices, most helium now sold for balloons is mixed with air. This lowers cost and helium use, but it makes balloons less buoyant, and dramatically reduces the impact of the gas on your voice. This may be significant to the comic because it means the average person is unable to change their voice with helium, so when Cueball is given access to a vast supply of it, he can no longer help himself.

Another realistic but admittedly less funny explanation is that Cueball didn't use up all the helium frivolously: helium is lighter than air, and once released into the atmosphere, it escapes into space and can never be recovered. A major leak in the Reserve would simply mean that all the helium is lost, and if it happened under Cueball's watch, he'd have to be held responsible -- and it is hard to find materials helium doesn't leak through at an astonishing rate. Firms that try to earn money by transporting heavy cargo using dirigibles (the successful transportation of an airplane wing, a wind turbine or any other large item where the roads are too narrow might be worth considerable amounts of money to those with the means to do so) often fail due to the costs associated with helium leakage.

The title text addresses the real-world privatization of the Reserve, first selling off the helium itself and then the sale

of the storage facility. This has been a drawn out process because of political disagreements; however, the title text implies the simpler explanation that one guard (or perhaps the government in general) has inhaled all the helium so there is nothing left to sell off.

#2767: Recipe Relativity

April 24, 2023

Black bean burrito bowl

Total time: 35 minutes

MY ACTUAL TIME: 1h 45m

$$t = \frac{t'}{\sqrt{1 - \frac{v^2}{c^2}}} \quad v = c \sqrt{1 - \left(\frac{t'}{t}\right)^2}$$
$$= c \sqrt{1 - \left(\frac{35}{105}\right)^2} = 0.94c$$

I THINK THIS RECIPE AUTHOR IS MOVING
PAST ME AT 94% OF THE SPEED OF LIGHT.

It says to cut the onions into 1/4" slices, but I'd better
correct for length contraction.

Explanation

In this comic, Randall is cooking a recipe found online. It took him much longer than the recipe said it would, and he concludes that this was due to time dilation as described in the theory of special relativity; that is, the recipe author was moving at 94% of the speed of light, causing relativistic effects, so that only 35 minutes passed for the author while 105 minutes passed for Randall. To calculate the 94% figure, he takes the recipe's official duration (t') and his actual duration (t), and then calculates what speed of light fraction would account for the cooking time difference.

This is absurd[citation needed] and therefore humorous primarily because the most likely cause of the difference in time is that Randall is less skilled in making the recipe than its author, rather than relativistic effects. The recipe author would report the time in their own frame of reference, not Randall's, no matter what the difference in motion between the two.

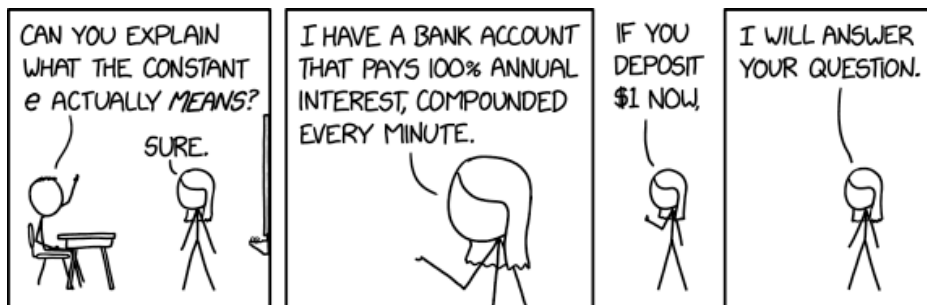
Randall is poking fun at online recipes that state an optimistic cooking time. The recipe author may assume an ideally equipped kitchen, a skilled chef, and the availability of prepared ingredients, such as canned or frozen cooked black beans instead of dried beans which take over an hour to soak and cook.

The title text takes the relativistic theory even further, saying that because of Lorentz contraction caused by the

recipe author moving close to the speed of light, Randall should use different sizes of ingredients. If the recipe author calling for $1/4$ " onion slices is indeed traveling at 94% of the speed of light relative to Randall, he wonders whether his onions should be cut to $3/4$ " slices to match their size in his frame of reference. This is similarly absurd and therefore humorous.

#2768: Definition of e

April 26, 2023



Yeah, my math teacher back in high school set up the system to try to teach us something or other, but the 100% rate was unbelievably good, so I engineered a hostile takeover of his bank and now use it to make extra cash on the side.

Explanation

In this comic the teacher Miss Lenhart is asked by the student Hairy to explain what the constant e actually means.

The mathematical constant e is known as Euler's number. It is typically demonstrated in terms of compound interest. Here, Miss Lenhart seems to be setting up such an example, but in a typical Lenhart style she is actually asking her student to give her money.

The constant e can be described in the context of compound interest. For a bank account that pays interest at a rate of 100% per year, and that interest is paid n times a year and compounded, then a \$1 deposit will grow to $\$1 * (1 + 100\%/n)^n$ after a year. As n approaches infinity (continuous compounding), the amount approaches e dollars. In the comic, minutely compounding is used as an approximation of continuous compounding; here $n = 365 * 24 * 60 = 525,600$ (527,040 for leap years with 366 days), and the resulting amount would be \$2.7182792..., less than one part per million different from that of a straight multiplication by e (which is 2.7182818...).

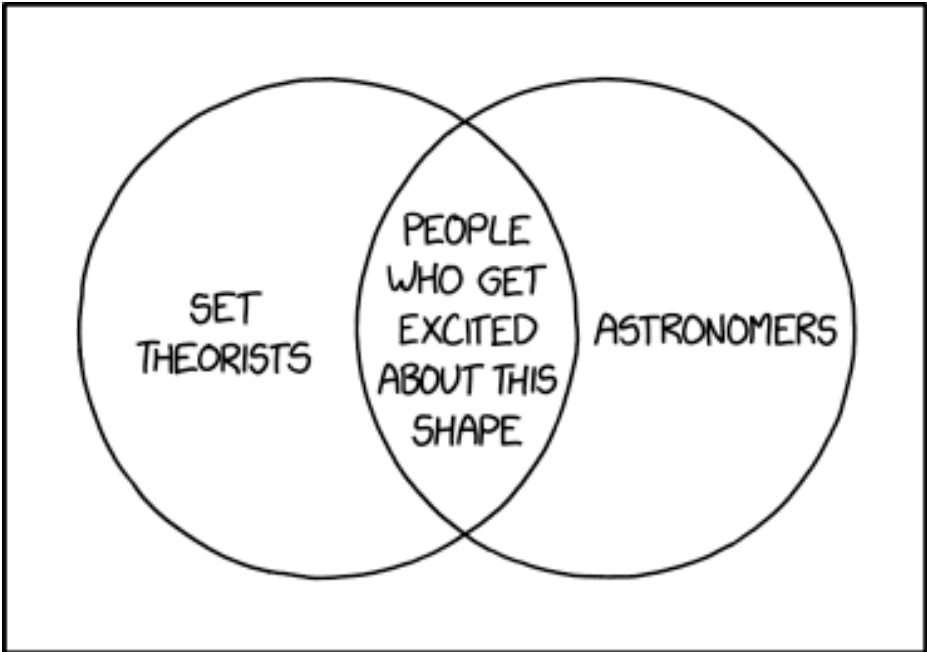
As such, one would expect Miss Lenhart to say in the last panel something like "you'll have e dollars in a year". The joke here is that she instead uses the normal beginning phrase ("If you have \$1...") and turns it into a charge to answer the question ("I will answer your question.")

In the title text, Randall remembers that his high school teacher, like Miss Lenhart in the comic, had a bank account that paid 100% annual interest. This is an extremely high rate, and a bank that is able to offer it must have a very lucrative source of revenue. Therefore, he bought the bank, via a hostile takeover, in order to gain direct access to that source, and now uses it as a source of supplementary income. It is unlikely that this story is true.[citation needed]

It is also plausible that the title text is Miss Lenhart explaining how she acquired the bank to set up her account there, and that she regularly charges people \$1 for trivial services, such as explaining concepts to her students.

#2769: Overlapping Circles

April 28, 2023



"The Venn diagram of the sun and the moon is a circle."
--someone being snarky at totality

Explanation

The comic shows two overlapping circles. This is a simple example of a Venn Diagram, which is a way that set theorists often illustrate the relationships between sets. Venn diagrams can consist of a number of overlapping shapes to describe the similarities and differences between any number of objects. Up to three overlapping circles can be used to represent every combination of membership of those separate sets. Beyond this, circles cannot suffice and other shapes (ovals or even concave shapes) are needed, but just two such areas is as trivial as shown, with the portion of the diagram where the two circles overlap represents the intersection of the sets (items that are in both sets). There are several other comics about Venn diagrams.

The two sets in this diagram are set theorists and astronomers. Set theorists would find the shape here interesting because such diagrams would appear regularly in their work. Astronomers also find overlapping circles interesting, because this is what they see during eclipses, when one astronomical body is directly or partially in front of another. In the overlapping section in the middle would be people who are both set theorists and astronomers. The joke here is that these people would be particularly excited by the shape, because it represents the overlapping of both their fields of study.

Note that Randall seems to have chosen humor over scientific accuracy. Read literally, this diagram appears to

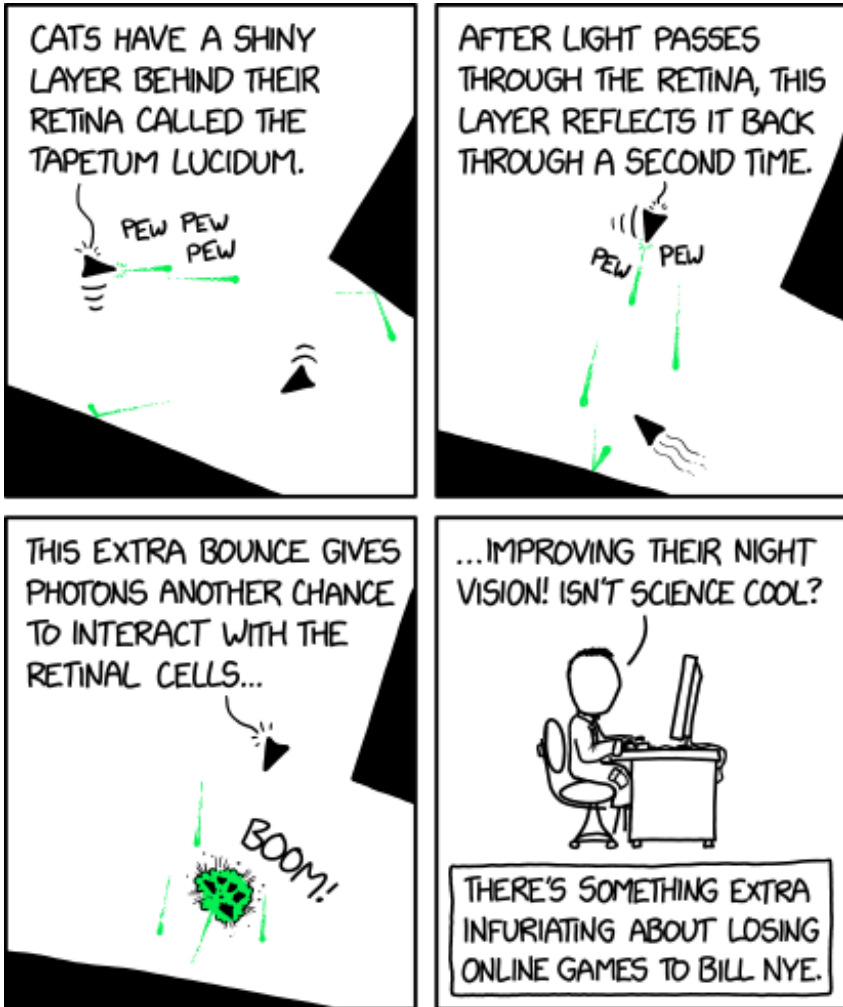
be saying that the only people who are excited about the shape are those who are both set theorists and astronomers. The label that is in the intersection of the two circles should properly apply to their union. However, a pedantic person might note that the label is actually within the union of the two circles, so perhaps all is well after all.

A common snarky comment on the Internet is "The Venn diagram of [x] and [y] is a circle" (for example, "xkcd" and "peak fiction"), implying that the two sets are identical. Totality describes a total (full) eclipse, when one astronomical body completely blocks the light from another. During totality, the shape of the eclipse is a circle. The title text references the totality that occurs during a total solar eclipse and its corresponding shape (or "Venn diagram," as the title text phrases it).

This comic was released 8 days after the Solar eclipse of April 20, 2023, which was visible across parts of South East Asia and Australia, and of which an excited astronomer would certainly be aware.

#2770: Tapetum Lucidum

May 01, 2023



Using a reflective wall in a game to give one shot two chances to hit is called a double-tapetum lucidum.

Explanation

Bill Nye, perhaps best known for his children's educational series *Bill Nye the Science Guy*, wearing the same lab coat as in 200: Bill Nye, beats an unseen player (presumably Randall) in an online multiplayer game resembling *XPilot*, in which players pilot spaceships using simulated rocket physics and attempt to shoot and kill each other. During a laser battle, Bill Nye provides a scientific explanation for the tapetum lucidum, the layer behind the retina of a cat's eye. He explains that the layer reflects back some of the light that passes through the retina, giving it a second chance to hit the retina again. This allows a cat's eye to capture more light than it otherwise would, and thus improves their night vision. It's also why cat's eyes appear to glow in the dark.

At the same time, Bill Nye's battle tactic in the online game perfectly analogizes the point he is making. His spaceship is firing energy pulses into the path of an approaching ship in an attempt to destroy it. Due to the difficulty of hitting a small, fast-moving target, it's likely that most or all of these shots will miss. However, because Bill Nye is firing at a reflective wall, each shot that misses bounces back into the path of the opponent's ship, giving it a second chance to hit the target and effectively doubling the density of the firepower. With double the number of shots to avoid, the opponent's ship is hit and explodes. This explanation is similar to how Bill Nye would explain scientific concepts by using analogous demonstrations of other things.

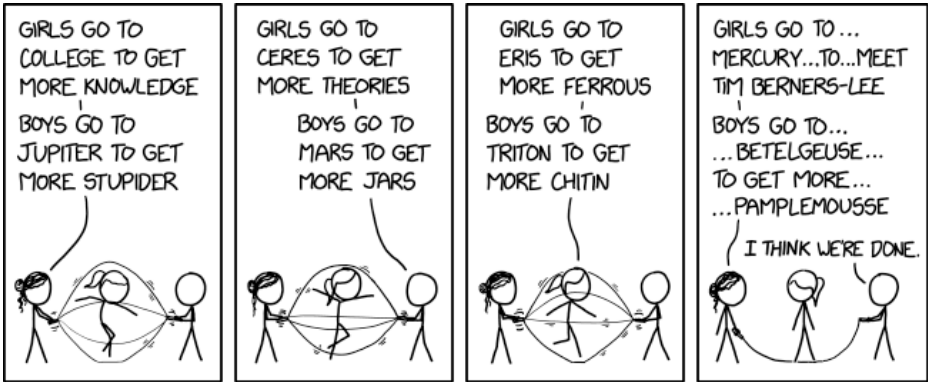
In the analogy, the weapon shots fired by Bill Nye's ship are the light photons entering the cat's eye, the reflective wall is the tapetum lucidum, and the opponent's ship is a retinal cell. Destroying the opponent's ship with a shot is analogous to a light photon being absorbed by the cat's retina (and therefore seen). If the reflective wall hadn't been there, the ship might have survived, which means the retina would never have seen that photon.

Randall presumably considers this "extra infuriating" because Bill Nye is showing both his scientific knowledge in some other field and his gaming prowess simultaneously, while he lacks the skill even to win the game normally.

The title text is a pun that refers to "tapetum lucidum" and uses "double tap" in the way that online games, memes, and films refer to shooting something twice in rapid succession to ensure its demise. This phrase is used in the film *Zombieland*, and is the subtitle of the 2019 "*Zombieland: Double Tap*" sequel.

#2771: College Knowledge

May 03, 2023



'Your chitin armor is no match for our iron-tipped stingers! Better go hide in your jars!' --common playground taunt

Explanation

This comic and 1202: Girls and Boys are plays on the common playground rhyme which children will often recite when divided by gender is that "girls go to college to get more knowledge; boys go to Jupiter to get more stupider," also commonly heard as "Boys go to Mars, to get more candy bars; girls go to Jupiter, to get more stupider." The words "boys" and "girls" may be interchanged, depending on the gender of the person chanting (or how intelligent they are, for that matter). The schoolyard taunt embodies the competitiveness and separation commonly seen between young boys and girls, and ideas about the superiority of one's gender.

Starting out with this cadence, three characters (or child versions) jump rope and explore parts of the solar system and beyond by taking it in turns to provide the rhythm's tempo. First Jill (who is turning the left end of the rope), then a Cueball (at the right), followed by a Ponytail (doing the jumping), before returning to Jill. As they concentrate on various stellar bodies that are harder and harder to rhyme, their chants become increasingly hesitant and obscure, ruining the rhythm, and resulting in ever more contrived "rhymes", to the point where they eventually seem compelled to abandon the whole game.

The title text refers back to some of the rhymes the characters mention, making sure to stay consistent with whichever gender acquires which object. Speaking from the perspective of the college-bound gender, who had

acquired ferrous iron from Eris (or perhaps become more composed of it, by bodily transformation), the girls playfully threaten the boys with iron-tipped stingers, for which the boys' acquired armor of chitin (a material commonly found on the exoskeletons of various insects, including in any stings these might normally have) from Triton is purportedly no match. The girls then also refer to the jars which the boys had acquired from Mars, telling the boys that they'd better hide in them if they wanted any sort of protection from the iron-tipped stingers. To top it all off, the title text finally claims that this is supposedly a "common playground taunt" among children, which implies the unlikely outcome that the bizarre and unwieldy rhymes which the characters in the comic created have somehow persisted and passed into common usage enough to be generally recognizable.

In 1202: Girls and Boys, boys and girls both go to college and to Jupiter, both to get more knowledge.

#2772: Commemorative Plaque

May 05, 2023



[Below] On this site on May 12th, 2023, I finally learned how to use the masonry bit for my drill.

Explanation

The narrator discovered that it is simple and inexpensive to have a commemorative plaque made, and so had a commemorative plaque made to record that event. The comic both indicates the lack of knowledge many people have about how simple or difficult it is to do a certain thing, and the over-the-top response a person might have to a relatively mundane discovery.

The comic was published on May 5, the holiday of Cinco de Mayo, Europe Day and Dutch Liberation Day, and the day before the Coronation of Charles III and Camilla. The comic subverts an expectation that a plaque about May 5 would be to commemorate either one of the many world events that previously took place on a May 5 in various years, or more specifically the 1862 Battle of Puebla or the 1964 founding of the Council of Europe or the 1945 Liberation of the Netherlands, which all took place on May 5 and inspired the respective holidays.

The title text describes a second plaque mounted below the first one, boasting that a week later they learned out how to use a masonry bit, presumably to mount the first plaque onto a stone wall.

The earlier comic 699: Trimester also features a similar situation in which a seemingly official and authoritative item can in fact simply be purchased by a layperson.

#2773: Planetary Scientist

May 08, 2023



PLANETARY SCIENTISTS ARE STARTING TO
SEE SUBSURFACE OCEANS EVERYWHERE.

This rumpled fabric at the corner looks like evidence of ongoing tectonic activity.

Explanation

Ponytail, a planetary scientist, is shopping at a mattress store. The store clerk seems to be giving her a guided tour of various models of mattress, including the most popular model shown in the comic.

Ponytail asks if the bed is a waterbed, a type of mattress which is filled with water instead of the usual solid material. The clerk, Cueball, begins to explain to her that it's actually a hybrid made of foam (among other things, maybe water, but it's usually the terminology used for a significantly hi-tech foam/spring combination construction, rather than just the former or the latter with or without minor padding), but Ponytail interrupts him, saying that she believes it actually is a waterbed based on "how it moves."

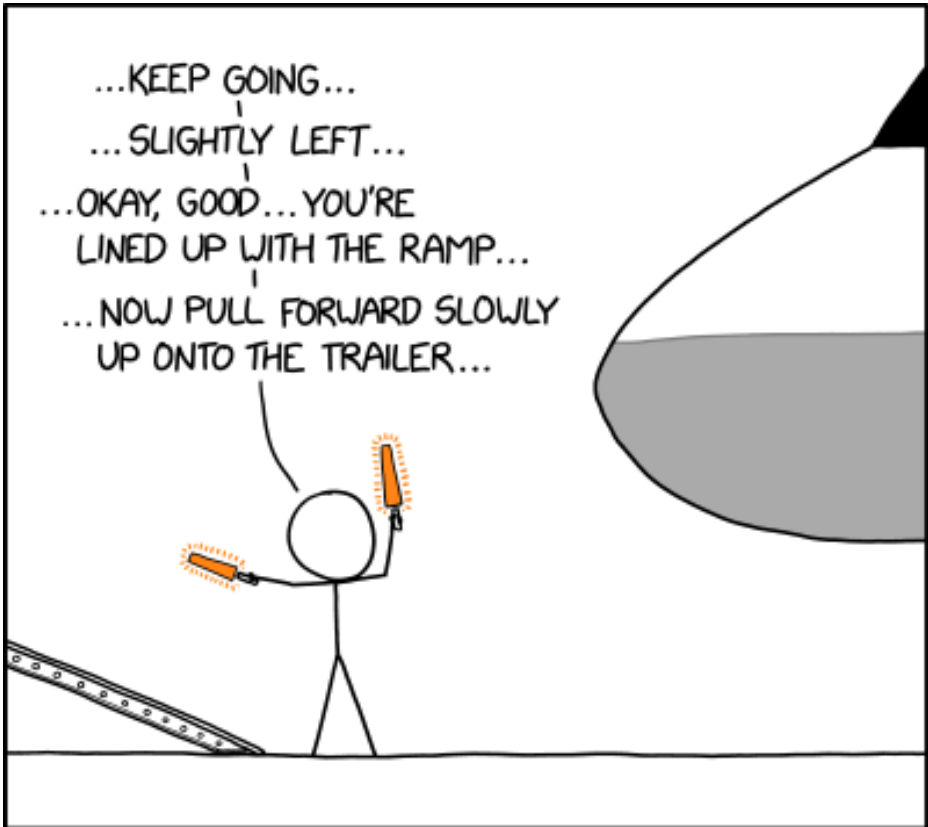
The comic caption reveals the punchline, that because subsurface oceans have become so ubiquitous in the study of planetary science (especially because they serve as an indicator for the potential for life on another planet), Ponytail is starting to see them everywhere, even in clearly unrelated contexts such as mattresses. Here, the water in the waterbed is analogous to a planet's subsurface ocean (i.e. both being water underneath a solid outer layer). Alternatively, the comic could be commenting on the difficulty of discerning hydroxyl spectra of water absorbed in mineral hydrates from free water in remote detection studies of the Moon, asteroids, the moons of Jupiter and those of other large planets, like

Uranus.

The title text goes in a similar direction with planetary science, having Ponytail tell the now-confused clerk that the rumpled fabric on one part of the bed seems like "evidence of ongoing tectonic activity," referencing tectonics and how protruding geographic formations (such as mountains) are formed through it. Again, the punchline is the relentless penetration of Ponytail's occupation into her everyday life. Typically, however, rumpled fabric may be caused by someone pushing the fabric on a bed, or just not making the bed carefully enough, and not 'mattress tectonics' as Ponytail suggests; though this might well be a humorous reference to sexual activity, which often takes place on beds and frequently causes fabric rumpling, as has been previously referenced in *xkcd*.

#2774: Taxiing

May 10, 2023



I DON'T UNDERSTAND WHY ANYONE WOULD PAY
FULL PRICE FOR AN AIRPLANE WHEN YOU CAN BUY
THOSE GLOWING WAND THINGS ONLINE FOR LIKE \$30.

I don't understand why anyone would pay full price for a
flatbed truck rental when you can buy 'DETOUR' signs
online for like \$10.

Explanation

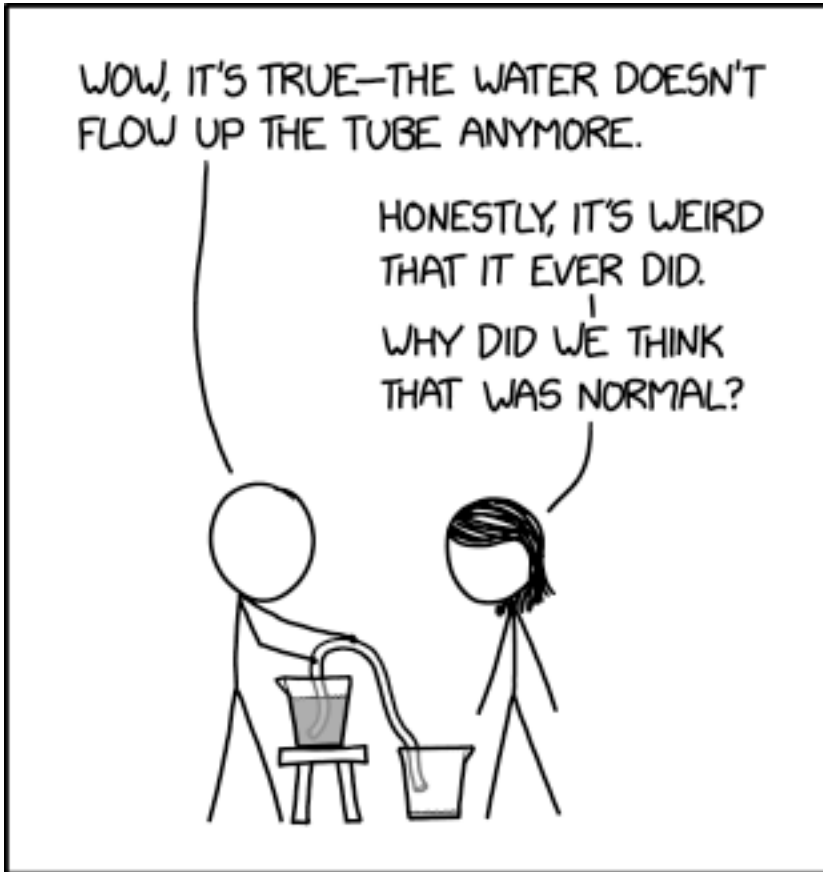
In this comic, Cueball is directing an airplane with marshalling wands onto a ramp that leads onto the trailer of a flatbed truck. The caption reveals he is not an actual aircraft marshal: instead he is tricking the pilot into driving the plane onto the trailer. Randall, as Cueball, says the "glowing wand things" (the marshalling wands) were bought cheaply on the internet, at a cost much lower than that of the plane he is now stealing.

The word "ramp" can also refer to the apron of an airport, the area where marshallers most often work. A pilot may be quite used to having their plane directed onto that form of ramp, and not notice that Cueball is using the word in a different sense.

The title text suggests that Cueball did not even pay to rent the truck: instead, he placed "Detour" signs on the road to trick the driver into driving the truck into place for loading.

#2775: Siphon

May 12, 2023



PHYSICS NEWS: THE 2023 UPDATE TO THE UNIVERSE FINALLY FIXED THE "SIPHON" BUG.

ADDITIONAL NOTES: Fixed a bug that caused some rocks to generate virtually infinite heat while just sitting there.

Explanation

Cueball and Megan have set up a simple experiment to test how a siphon works, using the gravitational force on a lower portion of liquid-filled tube, atmospheric pressure on the upper reservoir, and molecular cohesion within the liquid, to move a liquid upwards through a bit of tube at a higher gravitational potential. In short, the liquid passes over a higher peak to reach a lower exit. Randall has also mentioned siphons in *Europa Water Siphon* and in *How To* (section "How to Throw a Pool Party").

Siphons are commonly used in modern society (e.g., most American residential toilets are flushed by siphon action). Siphons should not be confused with capillary action.

Apparently, even though Cueball and Megan have set up the experiment correctly, the water no longer demonstrates a siphon by flowing from the upper bucket to the lower. Cueball observes in surprise that "it's true," that siphoning doesn't work anymore. Thus indicating that this is a very recent development, and Megan remarks that it was honestly weird that it ever worked, and muses over why we ever thought that was a normal thing.

The punchline of the comic comes in the caption, which delivers a piece of *Physics News*: "The 2023 update to the universe finally fixed the "siphon" bug." The joke here is

that the entire complex and multifaceted system of physics in and of itself is treated as though it is simply the coded logic running the universe (or perhaps the sometimes unintentional result of various default configuration options like in a video game - see 1620: Christmas Settings), and that siphoning (rather than being an interesting physical phenomenon worth studying) was nothing more than a bug in the Universe. It has now been fixed, somehow and for some reason, being considered a glitch and not the intended behavior.

In reality, siphons still very much exist in our universe. Siphons require filling beforehand to function, either by initially actively sucking liquid through or by first immersing the siphon tube in any compatible liquid then ensuring it retains its contents as it draped over the obstacle and each end positioned properly into the respective receptacle, so it is plausible to imagine skeptical people “proving” they do not function by refraining from providing the initial priming. However, the small amount of water in the bottom of the bucket near Megan indicates that there was at least some water in the tube, and that this just ran down on either side, leaving the tube empty and a bit of water in Megan's bucket and a bit more in Cueball's bucket. So they did set up the experiment correctly, but since the latest update siphons do not work anymore. Or as they state it, the universe now works correctly and the siphon bug has been corrected.

A siphon requires that the weight of the liquid column on the "higher" side of the channel peak not exceed

atmospheric pressure, or else the liquid will split, leaving a partial vacuum. The observed failure could be caused by several kinds of changes to the universe. If there was a significant decrease in the ratio between the pressure of Earth's atmosphere and the force of gravity, the siphon would stop working. Eventually, the water in the "lower" side of the tube would dribble out, letting air in, and the water in the "higher" side would also drain back into the reservoir. If the density of water increased enormously, the increased weight of the liquid column would lead to a similar failure. If the molecular cohesion of water decreased drastically and the flow rate of the siphon was slow, air could bubble into the "lower" end more quickly than the water was flowing through, and eventually the tube would empty. The siphon could also fail more mundanely if the water had a lot of gas dissolved in it under pressure (as with soda water), because the gas would come out of solution and collect at the highest point of the tube.

The idea that we live in a computer simulation is also prevalent in our modern pop culture, most famously shown in *The Matrix* (See 566: *Matrix Revisited*).

The title text is an additional note to the 2023 physics update stating that the update has: "Fixed a bug that caused some rocks to generate virtually infinite heat while just sitting there."

This is a reference to radioactive materials that keep emitting energy (heat) almost indefinitely (on a human timescale). This is mainly a reference to uranium and

thorium and their decay chain.

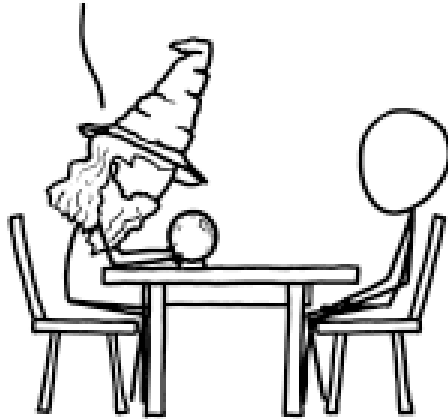
This is similar to the comic 2115: Plutonium, because plutonium (though man-'made', during nucleosynthesis) is used to power spacecraft. In that comic the title text has the same idea that someone controls the universe: It's like someone briefly joined the team running the universe, introduced their idea for a cool mechanic, then left, and now everyone is stuck pretending that this wildly unbalanced dynamic makes sense.

The entire comic is one of many where Randall muses over strange aspects of our universe, and wonders why we (people) ever think that it seems normal, the way the Universe works (or how humans work - see for instance 1268: Alternate Universe).

#2776: Crystal Ball

May 15, 2023

YOUR FUTURE IS HARD TO SEE.
I CAN MAKE OUT SOME HAZY
DETAILS IN THE CENTER, BUT
THE OFF-AXIS COMPONENTS
ARE PARTICULARLY UNCLEAR.



WIZARDS NEVER DID FIGURE OUT
HOW TO FIX SPHERICAL ABERRATION.

They often use ball lenses to collect light at the ends of optical fibers, so when you look stuff up on the internet you're actually scrying through a crystal ball.

Explanation

In optics, spherical aberration is an image imperfection that occurs due to the increased refraction of light rays that occurs when rays strike a spherical lens near its edge, in comparison with those that strike nearer the center. The origin lies within the fact that reflection/ refraction on a spherical surface is not perfectly focused on a single point, in contrast to paraboloid reflective surfaces, that have a single focus point. From the perspective of a viewer, this causes the image to appear blurry.

The comic makes the joke that, since a crystal ball is a sphere, anyone trying to use one for scrying or seeing the future would have to deal with this issue as well; the wizard is telling Cueball that he can only make out the parts of his future which are near the center, as the rest are distorted. Spherical aberration is specifically a property of refracted light, and since the crystal ball is presumably not showing an image originating from the other side of the ball (unless it is a hypersphere additionally extending itself though a time-like dimension), the image should not be distorted by both entering and leaving the sphere, perhaps only in the manner of a hemispherical lens (for which the internally formed holographic image-source perhaps could be properly anamorphically adjusted to exit in all directions a coherent manner). However, traditional scrying may have actually relied on spherical aberration, to allow unexpected shapes to emerge from subtleties such as surrounding flickering candles, that the seer may have

used to amplify intuition and visions.

The comic also incorrectly implies that spherical aberration only affects the edges of the image, possibly confusing it with field curvature. In reality, spherical aberration affects the full field of view.

The comic is also making use of the vague meaning of something being "hard to see". One would expect that this would mean that Cueball's future is vague or mysterious, as is often the case in many fantasy novels. But in this case, the wizard is telling Cueball that his future is literally hard to see due to the spherical aberration.

The title text observes a real-world action that could technically be described as "scrying through a crystal ball", that being the usage of the internet. Information over the internet is often transmitted via light sent through fiber-optic cables, which is sometimes collected using ball lenses. Due to the similarity between ball lenses and crystal balls, Randall argues that this is technically scrying through a crystal ball because you're receiving information from elsewhere (searching for something) and receiving it by way of a crystal ball (through the ball lenses). This is flawed as any lenses at the end of a fiber optic cable are to assist a detector in decoding potentially billions of light flashes per second into computer signals as opposed to actually allowing a human to view the contents of the internet with their eyes.

#2777: Noise Filter

May 17, 2023

A hand-drawn UI mockup of a restaurant search interface. At the top is a search bar with a magnifying glass icon and the text 'RESTAURANTS'. Below it is a 'FILTERS' section. The 'HOURS' filter has three buttons: 'ANY', 'OPEN NOW' (highlighted in blue), and 'OPEN AT...'. The 'RATING' filter has five buttons: 'ANY' (highlighted in blue), '☆ 3+', '☆ 3.5+', '☆ 4+', and '☆ 4.5+'. Below the ratings is a 'CURRENT NOISE LEVEL' section, which is circled in red. It contains a slider with labels '60dB', '70dB', '80dB', '90dB', '100dB', and 'ANY'. The slider bar is blue, and the handle is a small blue circle positioned between 80dB and 90dB. A red arrow points to the 'ANY' label. Below the noise filter is a 'PRICE' filter with four buttons: '\$' (highlighted in blue), '\$\$', '\$\$\$', and '\$\$\$\$'.

THIS FEATURE SHOULD AUTOMATICALLY
APPEAR WHEN YOU REACH AGE 30.

Party Mode also enables the feature, but reverses the slider.

Explanation

This comic portrays a generalized, minimalist version of a search engine's front end. The engine helps the user find things (in this case, restaurants) that conform to user preferences. Preferences shown are hours of opening, mean of review scores, price range, and current noise level. All but "current noise level" are rendered less prominent by being drawn in gray, with various typical choices applied; the exception being marked for the reader's attention with a red-circled (and arrowed) overlay. The user, setting the parameters for their search, adjusts the slider to select the maximum tolerable noise level. Taking the slider for increasing noise tolerance past 100 db is eventually interpreted as "Any", or limitless, whatever this might mean for any given position past 100 but not yet at Any. The high range (the 'safe' noise threshold is 70 decibels or less) tells us that the person designing the tool (Randall) may be accustomed to loud restaurants, probably including some that have been getting louder over time, or not actually that familiar and going only by a rough idea of what is necessary and possible.

The caption's statement that the noise slider should automatically appear when the user reaches the age of 30 (ignoring the privacy concerns implicit in such a function) plays on the common perception that a person's ability to tolerate background noise while dining (or anywhere else) deteriorates with age. Such declines have been documented, linked to changes in the inner ear

and associated nerves with aging, and can occur in the absence of other hearing-loss symptoms. The term "SPiN (Speech Perception in Noise) threshold" has been conceived to measure this loss. Other studies suggest that personality traits and gender, as well as age, contribute to declines in the ability to perceive speech in noise, so the trope is less precise than is indicated here, and in advertisements by health providers for hearing loss treatments.

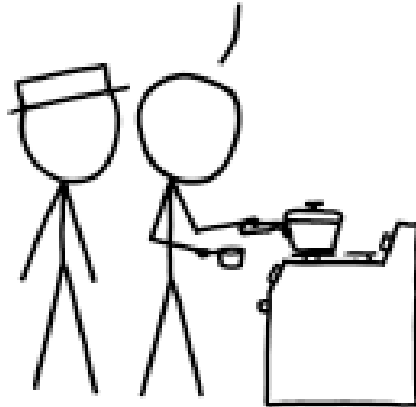
The title text shows that Randall imagines a "Party Mode" which also includes this filter, but reversed. Those younger than 30 may wish to filter out places that are too quiet and restrained and won't already have a 'party atmosphere' upon their arrival.

The criteria checked for some of the filter's options can be presumed to have been provided in advance by those running the restaurant (e.g. opening times, though perhaps derived indirectly from other web-listings promoting the business) or its customers (user ratings being aggregated from various online review sites), but the current noise levels will probably require some form of real-time monitoring installed in the premises, with or without the complicity/knowledge of the owners. Efforts are being made in this area, some of which suggest that a real-time measurement of overall noise won't be all that helpful to a restaurant patron, since the noise at a suitably-engineered table likely will differ significantly from the background.

#2778: Cuisine

May 19, 2023

NEXT, WE HEAT FOUR
CUPS OF HEAVY WATER
OVER VERY HIGH HEAT
UNTIL IT THICKENS AND
BECOMES RICH IN IRON.



I'M GETTING REALLY
INTO FUSION CUISINE.

My connection to it goes way back, to my early days, when I was just a cloud of primordial hydrogen collapsing in the darkness of space.

Explanation

Cueball is explaining a recipe to White Hat, describing it as Fusion cuisine, typically used to describe a style of cuisine based on combining aspects of the cuisines of two or more cultures,[citation needed] such as a combination of French and Chinese food, or Mexican and Korean food. However, he conflates this with nuclear fusion, combining atomic nuclei to create new kinds of atoms.

The recipe is described as the initiation of deuterium fusion in a kilogram ("four cups") of heavy water and allowing the reaction to continue to its endpoint, iron. The "very high heat" specified in the recipe would start at the four million-plus Kelvin at which deuterium fusion is initiated in stars, and could possibly reach the billions of Kelvin at which supernovas synthesize atoms heavier than iron, such as copper, zinc, selenium and iodine, which are essential in trace quantities for mammals. Unfortunately, heating a saucepan to even four million Kelvin would likely vaporize even the largest of kitchens, and any cooks therein. Most heavier elements are probably created when two Neutron stars spiral into each other (but they are remnants of super nova explosions).

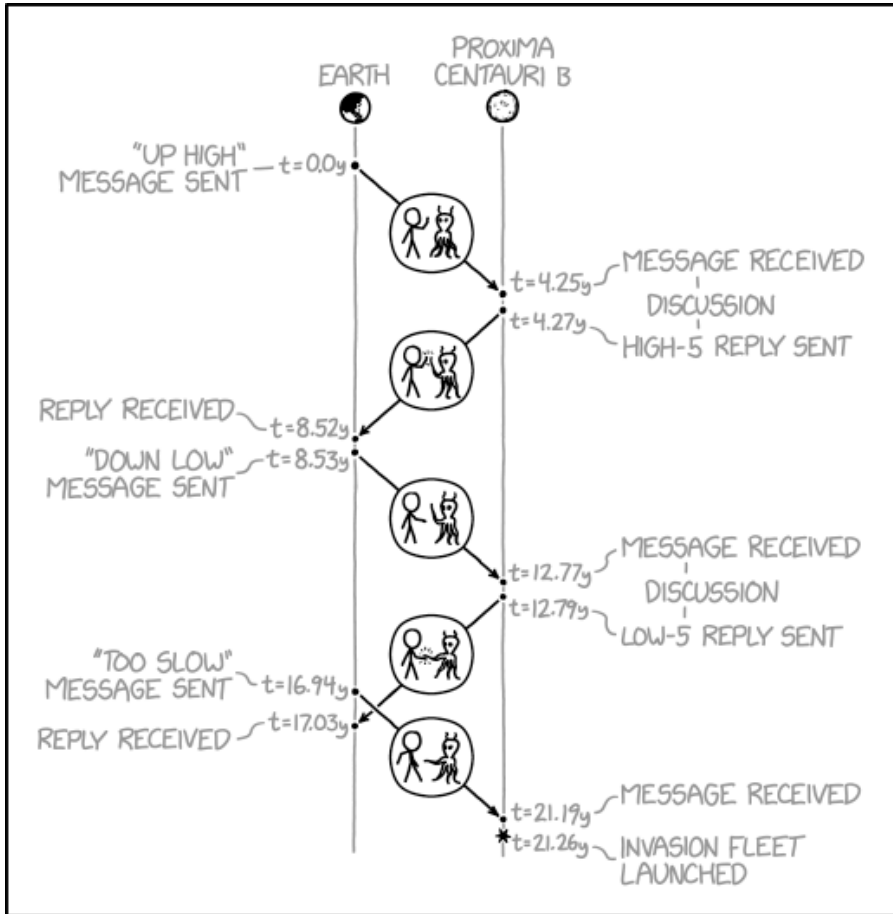
It should be noted that these are frequently omitted starting steps for every known recipe, as they are how the ingredients themselves are created.

The title text refers to the time before stellar fusion, just

after the Big Bang when most matter was hydrogen atoms. See 2723: Outdated Periodic Table for more on what other atoms were present. These primordial hydrogen atoms formed clouds that eventually collapsed into galaxies, forming stars that then created all heavier elements in one way or another. It took a long time but eventually some of these hydrogen atoms created Cueball and everything else on Earth. See 1123: The Universal Label. People often say that an interest of theirs goes back to their "early days", referencing their childhood, but in this case it appears that Cueball's interest goes back to several billions of years before he was born, indicating that it is his atoms that are interested in this cuisine – not himself – as they were the ones around when his interest began. Actually mainly his protons. And it was because of their interest in fusing together that Cueball came to be.

#2779: Exoplanet High-5

May 22, 2023



21 YEARS AND 3 MONTHS AFTER I TAUGHT
THE ALIENS ABOUT HIGH-5s, THE WAR BEGAN.

Tau Ceti is farther away, so it took me 36 years to start
the war over updog.

Explanation

Up high, down low, too slow is a prank variant of a High five. In the comic, Earth has established communications with aliens living on Proxima Centauri b, the nearest exoplanet to Earth according to current knowledge, and Randall has taught them about a high-five.

Instead of physically slapping hands, the high-five is executed by transmitting messages, as in a Handshake (computing). The diagram in the comic is thus similar to a sequence diagram, one usually employed for describing network communication in computing. As the messages travel at the speed of light and Proxima Centauri b is over 4 light years away, the times in the diagram are measured in (Earth-)years. This is a very slow method of communication – a perfect setup for a "too slow" prank. We can also see that they are taking around 1/50th of a year (approximately an Earth-week) to cue up their considered response, yet clearly Cueball seems quite ready to respond in about half that time (though any quicker would get lost, and appear simultaneous, at the given precision of decimal places).

Having found this way of exchanging a high-five with aliens, Randall successfully pranks the aliens by sending the "too slow" message before their "Low-5" message can even arrive on Earth, and over an Earth-month before it actually does. This is similar to how, in the original prank, the prankster anticipates the provoked reaction and pulls their hand away after the victim started to

move but before the "Low-Five" can taken place.

The aliens do not take kindly to being pranked and start an interstellar war, presumably intending to invade Earth. It is not known at which speed the Centaurians' invasion fleet travels and, therefore, when it will reach Earth. The scale of the fleet is also unknown, and with good fortune, it may again prove to be microscopic.

The title text refers to another prank, in which the prankster gets the victim to ask "What's updog?" This is usually done by saying a sentence or asking a question that contains the noun 'updog'. Should the victim of the prank be confused, they will likely ask for clarification as to what 'updog' is (i.e., "What's updog?") At this point, the prankster will then respond as though the victim had asked them 'What's up, dawg?', resulting in probable groans and embarrassment. More on the joke's history and prevalence can be found here.

Tau Ceti is a star almost 12 light years away. The exchange might have gone like this:

- $t=0y$: Randall: Hey, do you think it smells like updog in here?
- $t=12y$: Aliens: What's updog?
- $t=24y$: Randall: Nothin', what's up with you?
- $t=36y$: Message received, Aliens start war

"Updog" was previously introduced in 1696: AI Research.

This is an example of a type of joke called a henway.

#2780: Physical Quantities

May 24, 2023

REFERENCE PHYSICAL QUANTITIES:

HUBBLE VOLUME: 96L

SCHWARZSCHILD RADIUS: 0.34m (CURLED UP)

BROCA'S AREA: 1.7m^2

FERMI TEMPERATURE: 37°C

PLANCK LENGTH: 1.76m (LYING DOWN)

The Hubble length is about 1.9 meters lying down; Edwin Hubble was a tall guy.

Explanation

This comic plays on the name of various established physical definitions by simply taking them overly literally. Each one is treated as being a bodily measure of the scientist after which they are named, rather than describing/estimating the eponymous feature within the scientist's field of study. Interestingly, of the many units named for people, only one is actually a measurement of its namesake: the Smoot.

In cosmology, a Hubble volume (named for the astronomer Edwin Hubble) is a spherical region of the observable universe.

The Hubble volume is approximately equal to 1031 cubic light years (or about 1079 cubic meters).

The value given in the comic is the estimated volume of Edwin Hubble's body. The mean volume of a human body is around 65L, but Edwin Hubble was a big guy (see title text) and likely had an above-average volume.

The Schwarzschild radius of a black hole refers to the event horizon: the radius beyond which light cannot escape. Curling up in a ball tends to reduce people's radii,[citation needed] while making them more spherical and easier to measure, so Karl Schwarzschild's is given as 0.34 m, corresponding to a black hole of about 40 times the mass of Earth.

Broca's area is a region of the brain whose functions are

linked to speech. It is not a measurement of area in the sense of length times width. The measurement shown here purports to be the area of Paul Broca, which probably refers to the surface area of his body - about 1.7-1.8 m² for a typical adult. This area was recently mentioned in the title text of 2732: Bursa of Fabricius.

The concept of Fermi Temperature is related to the Fermi Energy, a quantum value inherent to very cold substances. The temperature of an average human is about 37 degrees Celsius, so it makes sense that Enrico Fermi's baseline body temperature was, likewise, 37 degrees Celsius. Since Fermi lived in the 20th century, and it may be possible to reference his medical records, this assertion is potentially testable, perhaps more readily than those made for the 19th-century persons named in this comic.

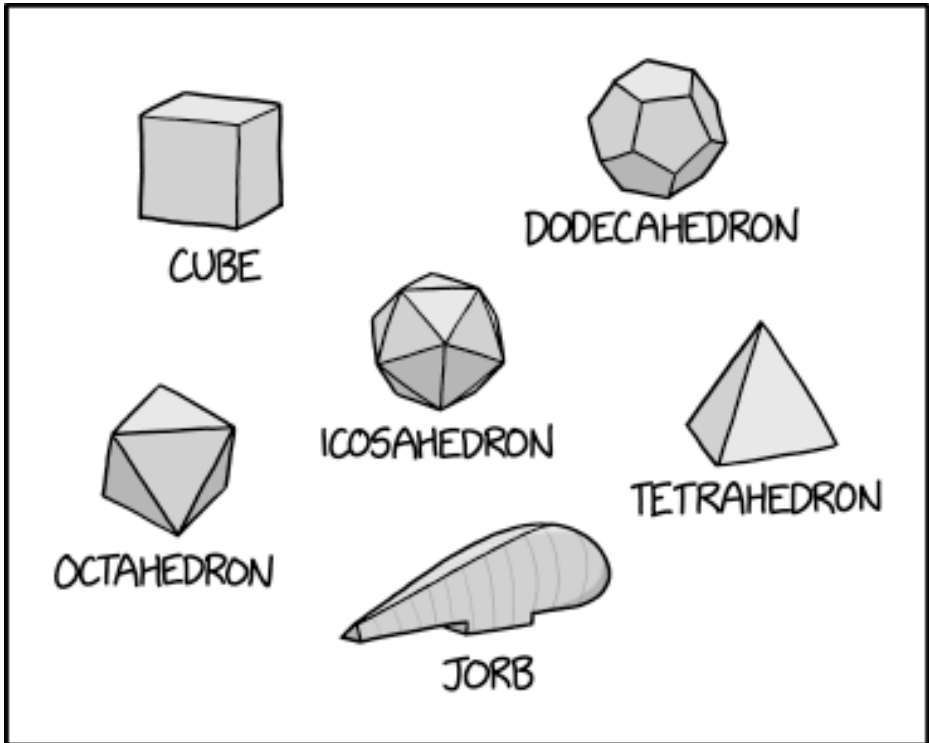
Planck units are naturally-derived measurements invented by Max Planck; the Planck length (approximately 1.6×10^{-35} m) is one of the smallest meaningful distances. However, Randall measures the length of Max Planck, not the units. It is specifically when Planck was lying down (as to not decrease his height from a days exposure to gravity which may shorten a human by a centimeter or so, and also because lying down turns a human's height into a length, as well as being a pun on the plank exercise, which is done in a horizontal position). His "length" is given as 1.76m, or roughly 5'9".

A Hubble length is 14.4 billion light years. This is a joke

similar to the above play on the Planck length. The Hubble distance would be the distance between the Earth and the galaxies which are currently receding from us at the speed of light. The joke is that the Hubble length is 14 cm longer than the Planck length because Hubble was a tall man. Another joke by comparing these two are that these two distances are about as far from each other as possible on scales that make sense. The smallest distance to something on the order of the size of the visible universe.

#2781: The Six Platonic Solids

May 26, 2023



MATHEMATICIANS LONG BELIEVED THERE WERE ONLY FIVE PLATONIC SOLIDS, ALL REGULAR POLYHEDRA, UNTIL THIS YEAR'S DISCOVERY OF THE JORB.

Plato made the solids, and five were gifted to the mathematicians. But in secret Plato forged a sixth solid to rule over all the others.

Explanation

This comic imagines an alternate reality where mathematicians discover a new Platonic solid beyond the five proven to exist in three-dimensional space. In three dimensions there are 9 regular polyhedra (though depending on who you ask, there could be as many as 48 of them). A regular polyhedron is a solid figure with all faces being congruent regular polygons with the same number of alike faces arranged around each vertex. While the most familiar, Platonic solids, are referenced in the comic, there are also 4 Kepler–Poinsot polyhedra. In four dimensions, there are six regular polytopes, five of which are analogous to the five Platonic solids in 3-D space, and a sixth which is analogous to the rhombic dodecahedron.

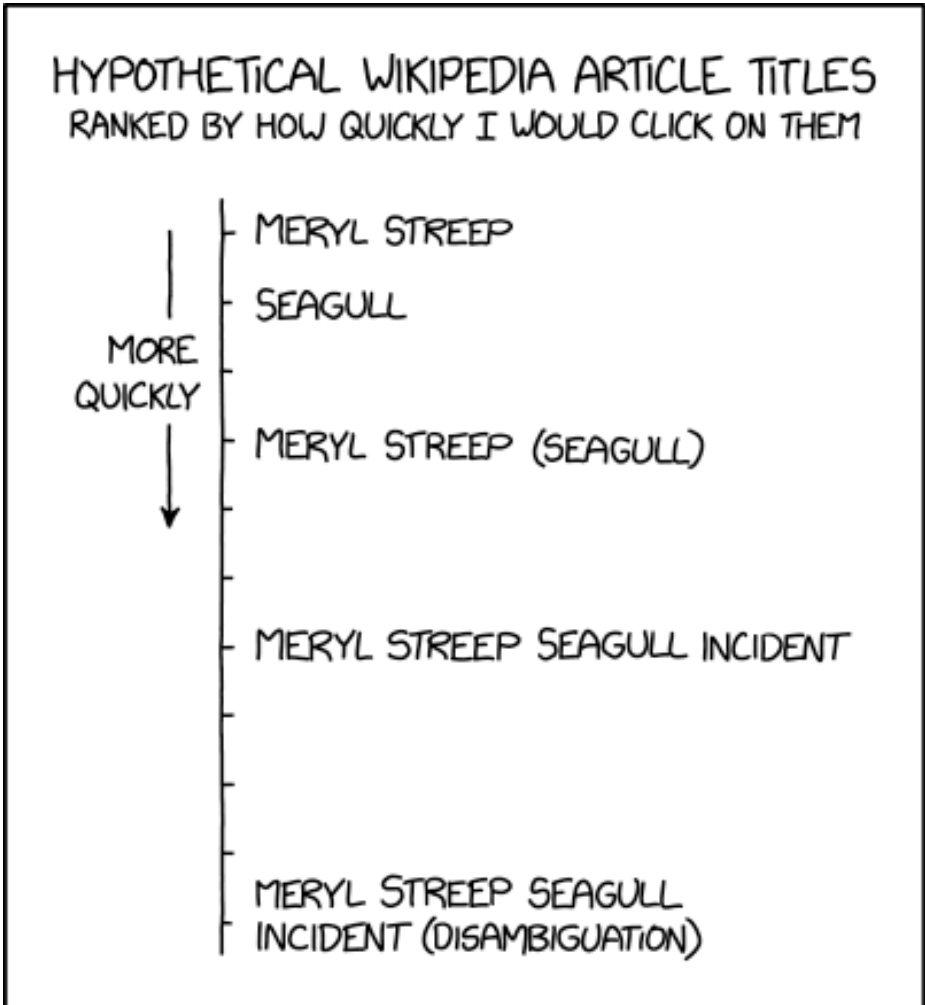
In the comic, Randall reveals the discovery of a new Platonic solid, called the "jorb", which appears to be a roughly conical shape with a round base, a triangular tip, and a rectangular extension at the bottom. One of its surfaces also seems to have parallel grooves or ribs, which may indicate curvature. The jorb does not meet the criteria for a Platonic solid, in that the faces must all be regular polygons of the same shape, and each vertex must join the same number of edges. Also, Platonic solids were discovered by Plato, who they are named after. A new-found regular polyhedra would not be called a Platonic Solid because it was not discovered by him.[citation needed] This could be a reference to the fact that many regular polyhedra have only been

discovered recently, most of which do not fit the naive understanding of a regular polyhedron, having irregular concave external faces, or being infinite or self-intersecting.

The title text references the Lord of The Rings, in which the "One Ring to Rule Them All" was forged in secret by Sauron to control the wearers of three magic rings given earlier to elves, seven given to dwarves, and nine given to humans, primarily by allowing him to know their location, letting him visualize the wearers and their surroundings, and by allowing him to impose his will on the wearers (which for arcane reasons only worked reliably on the rings given to humans, worn by the nine Nazgûl.) The joke is that Plato forged a sixth Platonic solid, the jorb, to rule the five he "gifted" to mathematicians, similarly to how Sauron tried to rule the other magic rings' wearers in Middle-earth with his One Ring.

#2782: Wikipedia Article Titles

May 29, 2023



I would never stoop to vandalism, but I'm not above discreetly deleting the occasional 'this article contains excessive amounts of detail' tag.

Explanation

This comic is a chart reflecting where various Wikipedia articles (real or imagined) might rank in how effectively they would act as clickbait for Randall.

Meryl Streep is a famous and widely acclaimed American actor. Randall apparently has little interest in reading about her, comparatively speaking, placing her article on the first tick of eleven, with more interest indicated further down the chart. Randall appears to have slightly more interest in reading about seagulls, on the next tick, which on Wikipedia redirect to the Gull article, because "seagull" is a common colloquial synonym. Two more ticks down from "seagull" on the scale indicating his increasing interest level, he suggests that a hypothetical Wikipedia link to "Meryl Streep (seagull)", which according to Wikipedia article title conventions could likely refer to a notable seagull also named Meryl Streep, would be more interesting to him.

A further three ticks beyond on Randall's interestingness scale is a hypothetical link to an article about a "Meryl Streep Seagull incident", which while possibly not conforming to Wikipedia's current requirements for sufficiently descriptive article titles, might refer to a notable event that occurred during the 2001 production of Anton Chekhov's play, *The Seagull*, at the Delacorte Theatre in which Streep was a lead actor (see "*The Seagull Opens its Wings in Central Park.*") According to an August 27, 2001 article in Salon, "a 40-ish man was

found dead in the bushes from a single gunshot wound near the Delacorte Theater in Central Park, just yards away from where [Streep's co-star] Philip Seymour Hoffman offs himself with a single gunshot wound every night as Konstantin Gavrilovich in Anton Chekhov's *The Seagull*." It is more likely that such an article would be about an incident in which a seagull notably caused Meryl Streep problems, or vice-versa, as in the Jimmy Carter rabbit incident, the subject of 204: America, and also referenced in 1688: Map Age Guide and 2086: History Department.

The final imagined Wikipedia page is a disambiguation page, depicted as four ticks further down and thus even more likely to be quickly clicked. Disambiguation pages are only necessary when there are multiple notable articles of sufficiently similar names which must be listed with clarifying details to avoid confusion. In this case, it may indicate that other variations of the aforementioned situations occurred in multiple incidents. A disambiguation page might also be needed to distinguish such an incident from one or more (possibly unrelated) films, books, rock bands, notable pets, or other entities which happen to be named Meryl Streep Seagull Incident. A musical group of that name could conceivably produce a self-titled album and song, further expanding the list of items on the disambiguation page. (The consequences of such a group having some unfortunate run-in with Meryl Streep and/or a seagull are left as an exercise for the reader.) Note, however, that the titles of disambiguation pages (i.e. with the

"(disambiguation)" portion visible as it is in the comic) rarely appear in links, as you usually reach them as a result of a search for an ambiguous term such as "go". Note also that disambiguation pages are not articles. The disambiguation page title is depicted as the greatest interest to Randall on the chart; presumably he would wonder how there can be more than one incident in which Meryl Streep and a seagull had some kind of noteworthy interaction.

The title text suggests that Randall is an inclusionist wikipediaian, and as such is not above occasionally deleting editorial message boxes claiming that their article contains too much detail.

#2783: Ruling Out

May 31, 2023

SO FAR OUR ASTRONOMY GROUP
HAS PUBLISHED STUDIES RULING OUT
THE EXISTENCE OF EARTHLIKE STARS,
EXOPLANETS IN OUR SOLAR SYSTEM,
HABITABLE-ZONE QUASARS, STARS
WITH SUBSURFACE OCEANS, AND
TECTONICALLY ACTIVE BLACK HOLES.



SCIENCE GOT WAY EASIER WHEN WE
REALIZED YOU WERE ALLOWED TO DO
STUDIES JUST TO RULE STUFF OUT.

We were able to replicate and confirm prior authors' detection of a moon orbiting the Earth with high confidence.

Explanation

Most science studies are intended to discover new knowledge. In astronomy, the goal is often to find different types of objects in space, or learn how astronomical objects are formed and behave. But often from studying things that exist, we also learn about limits of the kinds of things that can exist; when this happens, we say that we've "ruled out" the excluded phenomena.

Cueball lists five obviously[citation needed] impossible objects.

- "Earthlike stars": A play on "Earth-like planets" which scientists are very interested in finding. The Earth is not a star, hence stars cannot be Earthlike.
- "Exoplanets in our solar system": Exoplanets are by definition not in our solar system.
- "Habitable-zone quasars": Quasars in the habitable zones of stars are only theoretically feasible for relatively small black holes with active accretion disks in a star's habitable zone, visible from the Earth and brighter than the Sun, because of the technical criteria for classifying them in terms of their apparent magnitude relative to that of their galaxy. None such have ever been observed.[citation needed] While typical galaxies usually have only one quasar in their center, merging galaxies often have two far apart. Perhaps in 4-5 billion years, when the Andromeda Galaxy merges with our Milky Way, its microquasar might qualify, but that is

extremely unlikely.

- "Stars with subsurface oceans": Because the temperatures inside stars are higher than that which can support the existence of liquids as we understand them, stars cannot have subsurface oceans. After many billions of years, a white dwarf will cool to the point where it no longer emits significant heat or light, becoming a black dwarf, eventually cooling to the point where it might develop subsurface liquids.[actual citation needed] However, the universe is not old enough for any black dwarfs to exist yet, and sufficiently cool black dwarfs might not even be considered stars, but rather rogue planets.
- "Tectonically active black holes": Black holes do not have tectonic plates, so they cannot be tectonically active.

The joke is that you don't actually have to study anything to come to these almost patently obvious conclusions. The counter-proposals would need far more effort to even justify them as valid theories, by common understanding, and greater still to try to observe any supporting proof.

Some studies are also done to confirm the results of previous studies, to ensure that the conclusions were not mistaken or a fluke. The title text describes a study that was done to confirm the existence of a moon orbiting Earth, even though any sighted person can walk outside and see the Moon, the existence of the Moon has been known for at least as long as humanity has existed, and

the fact that it orbits the Earth has been assumed or known for upwards of 3,000 years. The ancient Greeks and Babylonians, for example, thought that the Moon orbited the Earth, though they lacked a detailed physical understanding of the system (they also believed, erroneously, that everything else in the universe orbited the Earth too). Anaxagoras (c. 500–428 BC) is credited with the correct explanation of lunar eclipses, and reportedly was the first to explain that the Moon shines due to reflected light from the Sun. However, it was not until the work of Nicolaus Copernicus in the 16th century that a detailed and accurate model of the Moon's orbit around the Earth was developed. Regardless, at this stage, a study to confirm the validity of Copernican orbits would contribute nothing to the scientific process, much less a study confirming the mere existence of the Moon.

#2784: Drainage Basins

June 02, 2023



HOW I STILL THINK OF THESE MAPS, DEEP DOWN

After a pail of water was thrown on the Wicked Witch of the West outside Salt Lake City, Utah's Great Salt Lake was measured to be 7 parts per trillion witch by volume.

Explanation

Alex Mack, the main character in the Nickelodeon show *The Secret World of Alex Mack*, developed superpowers after being drenched by an experimental substance. One of these is the ability to turn into a puddle of liquid.

A drainage basin is an area of land where all flowing water converges by one or more outlets to the same body of water. The comic shows a watershed map for the United States by depicting its drainage basins.

When Randall sees a map of the US's major drainage basins, he thinks of Alex turning into liquid and flowing as part of the basin she happens to be in at the time.

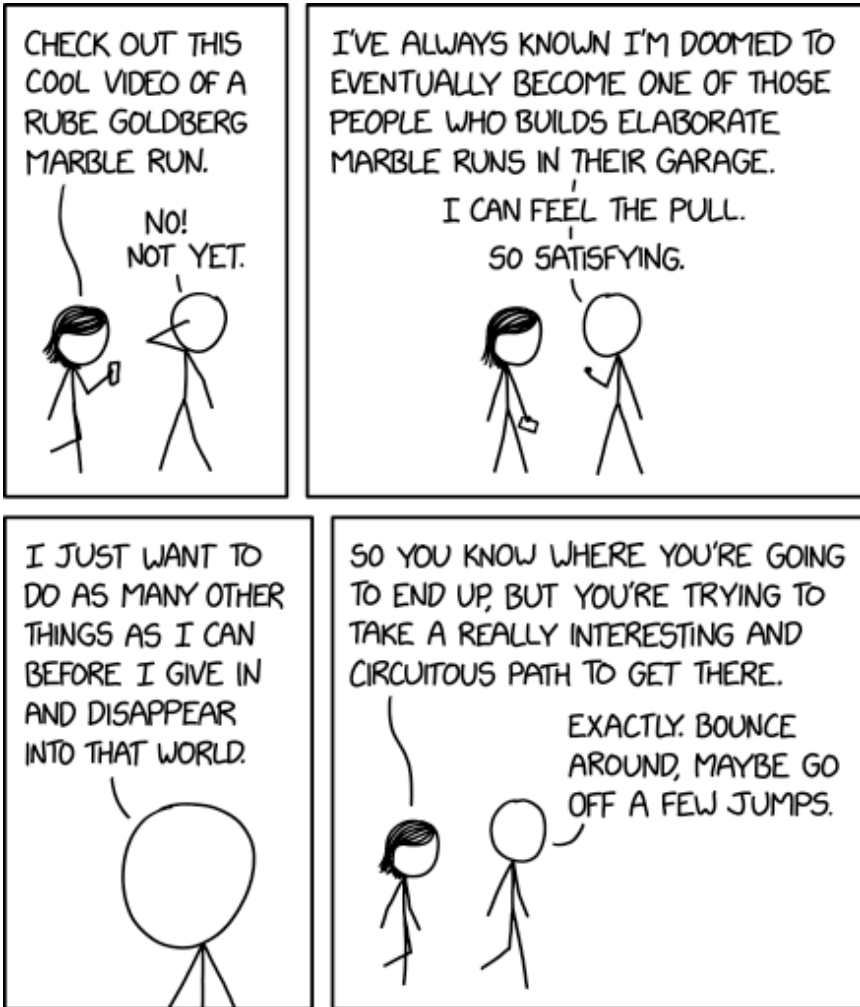
The title text refers to the Wicked Witch of the West, a character from *The Wonderful Wizard of Oz*, wherein a bucket of water is thrown on her, causing her to dissolve into a puddle. If this happens near Salt Lake City she would flow into Utah's Great Salt Lake, as its location in the Great Basin would prevent her from flowing to an ocean. If its dissolved particles are measured, a tiny fraction will be witch. Seven trillionths of the lake's nominal 18.93 cubic km volume is about 130 liters, which is approximately twice the volume of a typical human being. Randall may be approximating the lake's current, lower volume, which was 27% of its nominal volume at one point but has risen substantially in 2022-23 due to heavier rains than other recent years; or witches may be twice the size of normal people; or witch

matter may be particularly dense, and double in volume when dissolved in water; or he may be including the Witch's sister, the Wicked Witch of the East, as well. The Land of Oz is described to be somewhere else entirely, surrounded by desert, and thus perhaps has its own salt-lake basin(s); but famously it is not in Kansas, from which any witch-water would have ultimately flowed down to the Gulf of Mexico via the Mississippi. It is possible that Randall's choice of Salt Lake City is referencing the Surrender Dorothy meme that LDS temples look like Oz.

There is an error in the map. The map does not show the border between Michigan's Upper Peninsula and Wisconsin; in reality, this peninsula is part of Michigan.

#2785: Marble Run

June 05, 2023



I have so many plans. It would incorporate a Galton board, a Ranque-Hilsch marble vortex tube, and a compartment lined with pinball bouncers with a camera-and-servo Maxwell's Demon that separated the balls into fast and

slow sides.

Explanation

A Rube Goldberg machine is a fancifully complex system (either real or imagined), which makes use of an overly elaborate chain of actions. The name comes from an American cartoonist who was one of several people who became famous for depicting convoluted and outlandish processes for accomplishing simple tasks.

There's a long history of people building actual contraptions along these lines. Such devices are almost never intended for practical purposes, but exist entirely for entertainment, and as an exercise in building complex and carefully planned systems. This has become particularly common in the internet age, as videos of particularly interesting examples can gain popularity online. The most common category of these systems is probably the marble run (also known as a rolling ball sculpture), in which the goal of the system is to move one or more balls or marbles from the beginning of the arrangement to the end in interesting ways. This contrasts to the domino run where motions are transferred by many intermediate pieces painstakingly arranged, although both aspects are commonly combined in such contrivances.

When Megan tries to show Cueball an example of such a video, he refuses, not because he lacks interest, but because of how he predicts it will impact him. Cueball (likely as a stand-in for Randall), has sufficiently strong interest in things like designing, building and engineering

complexity that he's certain he will eventually adopt building such systems as a hobby, and that it will dominate his time and attention. Accordingly, he appears to be deliberately delaying his exposure to them so that he can continue to pursue other hobbies, with the assumption that he will eventually succumb to this one. Randall foresees the amount of time he might use if he first began trying to construct his ideas into a marble run.

Megan responds that he knows where he's going, but is taking "a really interesting and circuitous path" to get there. This draws a parallel between the type of systems he's avoiding and his approach to life more generally, which Cueball expands upon by suggesting he would do some of the things a marble typically would in a marble run.

The title text mentions specific ideas Cueball plans to incorporate into such a set-up.

A Galton board is a device that distributes falling balls into a normal distribution. Its design is similar to those used in pachinko-style games.

A Ranque-Hilsch vortex tube is a device for separating compressed gas into hot and cold streams. While such a device isn't directly applicable to marbles, one can imagine using the principle to separate a stream of marbles based on speed.

Pinball bouncers are properly supposed to be the Bumpers in Pinball machines. In Randall's marble run

there will be a compartment where the walls are lined with these bumpers. Supposedly there will be many marbles on the floor of this segment of the run, which will hit these bumpers and get a kick so they will move fast and randomly around the compartment, which is where the Demon comes in.

Maxwell's Demon is a thought experiment by James Clerk Maxwell which would violate the Second Law of Thermodynamics. Maxwell proposed that, if a container of air was separated by a divider, with a door that allowed only one molecule through at a time, and a theoretical "demon" were to control the door to sort high-energy atoms into one side and low-energy atoms into the other, the two sides would develop a temperature difference with no energy input. While such a system wouldn't actually be possible without energy input, it remains a compelling thought experiment.

Randall's version of this apparently involves the marbles bouncing around inside the bouncer-lined compartment, with an automated system to divert the fastest moving marbles into one side, and the slowest moving into the other, presumably to output higher velocity balls into one subsequent part of the arrangement, and slower ones into another. As these are macroscopic scales this would not be impossible, just really difficult.

Knowing Randall and his fans, some might design something using his ideas from this comic. In 2916: Machine, the readers built such machines.

#2786: UFO Evidence

June 07, 2023



[Decades in the future] "Well, the good news is that we've received definitive communication from aliens. The bad news is that they're asking about *Cats* (2019)."

Explanation

White Hat (presumably a ufologist) accuses Cueball of being unwilling to listen to his claims for extraterrestrial life. UFO stands for "unidentified flying object", but has become strongly associated with the belief that alien ships have visited or are visiting earth. People who believe this are likely to take the position that governments are systematically covering up evidence of alien contact, and the scientific community is either complicit or indifferent. Hence, White Hat accuses "you scientists" of refusing to even seriously consider evidence of his beliefs.

This strip was released after a number of news reports and US Senate hearings that reviewed unexplained aerial phenomena. While some of these remain unexplained, the general consensus remains that there is no real evidence that any of these phenomena are of extraterrestrial origin, let alone evidence of alien visitation. A devout UFO-believer is likely to be somewhat disappointed by this, and may take it as evidence that both political and scientific establishments are deliberately ignoring evidence.

Cueball counters this common pushback by admitting that he once spent an entire day trying to confirm the existence of a version of the 2019 film adaptation of *Cats* which allegedly gave the eponymous anthropomorphic felines anatomically-correct rear ends.

The *Cats* movie was widely panned, in part because of

the unappealing design of its CGI cat characters. On March 18, 2020, Twitter user @jackwaz claimed a friend of a friend had been hired as a VFX artist to "remove CGI buttoholes" from the digital cats, meaning that there was a version of the movie where the characters all had anatomically correct feline anuses depicted. This caused social media users to start petitioning for official confirmation of "the buttohole cut," which Universal Studios has so far declined to acknowledge.

Cueball's point is apparently that he (like many scientists) is driven by curiosity, and willing to spend a great deal of time and energy to answer questions. His suggestion is that, if he was willing to put effort into investigating such an inconsequential and ridiculous question, based on incredibly flimsy evidence, it's implausible that he would simply ignore actual evidence about something as important as the existence of sentient alien life. The only reason why he (and most scientists) would reject such claims is a total lack of even faintly compelling evidence. If someone ever managed to present evidence of alien life that was even slightly plausible, many scientists would enthusiastically spend a great deal of time and effort trying to verify it, as in 2359: Evidence of Alien Life.

This strip continues a common xkcd theme of mocking dubious claims, including UFOs, pseudoscience, paranormal phenomena, and Conspiracy Theories, which are presented without plausible or verifiable evidence. Randall's general attitude toward these claims is that, if any of these things were true, we would expect

evidence for them by now. Complaints that there is evidence, and scientists won't look at it are utterly implausible, because such evidence would be of enormous interest to scientists, if it was even slightly convincing.

The title text may refer to the idea that aliens could be watching our old TV (previously explored in 1212: Interstellar Memes). Because radio and television signals travel at light speed, aliens light years away could theoretically receive earth entertainment years after it was originally broadcast. The idea that they are learning about us from Cats, which is thought of as one of our worst films of all time, is not the view of humanity either most people would want to present or most people would not want aliens to show extreme interest in. Especially since they might ask for the butthole cut....

#2787: Iceberg

June 09, 2023



MY HOBBY:
REFUSING TO UNDERSTAND
THE ICEBERG METAPHOR

90% of the iceberg is hidden beneath the water, but that
90% only uses 10% of its brain, so it's really only 9%.

Explanation

This is another comic in the My Hobby series. The previous comic in this series was 2733: Size Comparisons, released just over 4 months prior. The iceberg metaphor is a famous metaphor sometimes misattributed to Freud. Just as a real iceberg floats with the vast majority of its body below the water's surface (often simplified as 90%, which does quite closely reflect the general range of buoyancy for ice in cold sea-water), the iceberg as metaphor represents a system where the large majority is unseen, invisible, or hidden in some way.

In this case, Ponytail is using it to illustrate the fact that about 95% of the mass in the universe does not appear to be in the form of ordinary ("baryonic") matter, but rather dark matter and dark energy. Dark matter is known to not interact at all with ordinary baryonic matter except by gravity, and has been detected only by its gravitational effects. Excluding dark energy, dark matter accounts for about 85% of the total mass of the universe. So baryonic matter is like the "tip of the iceberg," visible to us above the surface, while dark matter is like the invisible majority of the iceberg below the surface.

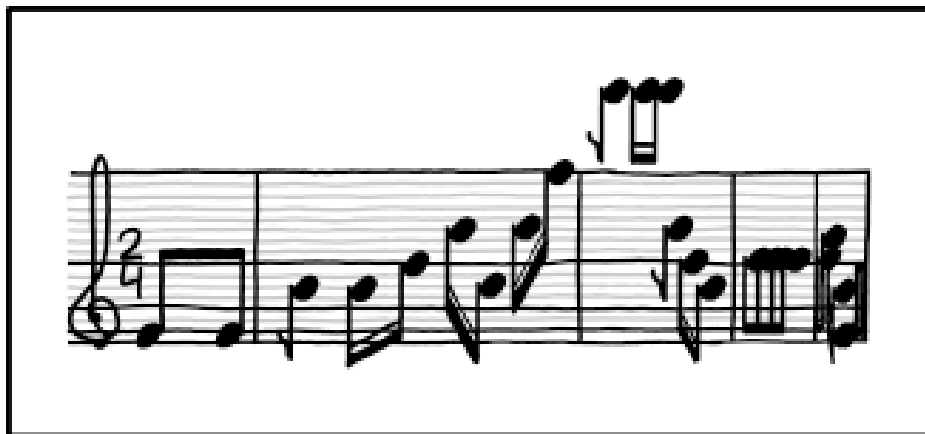
The questioner in the audience purposely misunderstands the metaphor by taking it literally, thinking that Ponytail is saying that the part of an iceberg below the surface is literally made of dark matter. He points out that the Titanic sank after its hull was damaged by hitting the underwater part of an iceberg,

which wouldn't be possible if it were made of dark matter. Cueball has previously been confused about dark matter in 2186: Dark Matter.

The title text references the myth that we use only 10% of our brain, and we could become more intelligent or powerful by "unlocking" the remaining 90%. If icebergs had brains, and the 90% in the "dark matter" part underwater used only 10% of its brain, while the tip also used 10% of its brain, then most of the cognition would occur in the underwater part. Hence the "9%" figure would refer to the cognition occurring underwater, with 1% of its cognition occurring above water. In reality, human beings use pretty much all of their brain. They just don't use it all at the same time; at any given instant, between 2% and 16% of neurons are firing, depending on how active the brain is in that moment. The effect of using one's whole brain would depend on precisely what is meant by that -- for example, all excitatory neurons firing with no inhibition for a prolonged period would be a seizure (most likely fatal), but there's no reason to exclude inhibitory neurons and adenosine when "using all of one's brain at once".

#2788: Musical Scales

June 12, 2023



WHEN TRANSCRIBING MUSIC, REMEMBER TO PUT
FREQUENCY ON A LOG SCALE AND TIME ON
A LINEAR ONE, NOT THE OTHER WAY AROUND.

In the Hall of the Mountain King was accidentally
composed on log/log paper.

Explanation

In standard Western musical notation, the horizontal position of a note indicates its relative temporal position in the piece, and the vertical position of a note denotes its pitch; but the pitch is really a logarithm of the note's frequency (every octave/seven named notes/12 semitones/13 named notes including accidentals equals a doubling of frequency), so it's a semi-log plot of sorts. The comic thus explores what a notation would look like if the horizontal axis behaved this way instead. Likewise, the vertical axis has been rendered linearly by frequency, with the normally equally-set lines on a normal musical staff stretching to compensate for the increasing jumps between pitches.

Randall may have mistakenly assumed that the lines of a music stave represent a linear increase in pitch and thus an exponential increase in frequency. He has thus mapped them onto a logarithmic scale by doubling the space between each successive line of the stave - one space between the bottom two lines, then two spaces, then four, then eight. In fact, the lines and the spaces between them correspond to notes in the C Major scale, which have unequal gaps between them. It is also possible that he is aware of this small inaccuracy and chose to ignore it in the name of humor.

The title text purports to explain how *In the Hall of the Mountain King*, which progressively increases in tempo/speed and intensity from an initially subtle start

into a rapid hustle towards a series of crescendos at the end, was written on log-log paper, that features nonlinear expansion in both its axes (in order to render various exponential graphs linear, often for the purposes of ease of understanding). Rather than these features being a deliberate composition decision, this says that they're only the result of how it was written down, or thenceforth read. The accident would have to be that music was originally written as though for log-log paper, using shorter notes as the piece went on, intended to have consistent actual durations throughout the piece—and then interpreted on a linear time scale, such that the later notes actually had shorter durations, speeding up the piece.

#2789: Making Plans

June 14, 2023



I'M REALIZING I SHOULD REALLY
SWITCH TO SORTING MY PHONE
CONTACTS BY MOST RECENT.

Oh no, I haven't checked in with Yvonne in YEARS.

Explanation

This comic is about bias due to alphabetical order. According to Wikipedia, "The practice in certain fields of ordering citations in bibliographies by the surnames of their authors has been found to create bias in favor of authors with surnames which appear earlier in the alphabet, while this effect does not appear in fields in which bibliographies are ordered chronologically." Similar effects have also been identified with the ordering of candidates on ballot papers. In essence, humans tend to favor whatever is at the top of any given list or data set, or may only assess the first few options until they reach one that is 'good enough', thus never evaluating those further down the list; this is one reason why random shuffling is important in any scientifically rigorous trial or opinion survey.

In the comic, Cueball is telling Megan about some of his upcoming plans; tonight he had arranged a meet-up with contacts whose names start with A or B, tomorrow's socializing involves a larger group of A-contacts, but there seems some doubt over some of them.

By this point, though, there is a clear pattern: Cueball has been contacting friends based upon their alphabetical priority in his list of names, instead of making more practical social decisions. One alternative is to maintain contact with those who (regardless of name) were already in more recent and ready contact, perhaps by rearranging the list by "most recently talked to". Although, arguably,

this could also be socially detrimental; anyone who happened to descend out of recent contact might never be contacted ever again. Again, these social pitfalls are something that almost everyone has to try to deal with, but Cueball's 'logical' way of handling it is ironically one of the more socially illogical methods available.

The title text continues the joke, implying that Cueball rarely makes it to the bottom of his alphabetical list; as such, he has not reached out to his friend Yvonne in a very long time. She may even have assumed he has been ghosting her, having seemingly not attempted to make return contact for that while either, but Cueball seems unable to distinguish between willing and enthusiastic contacts in general so his general social ineptness may be as much to blame as the enforced alphabetical priority of his friendship groups.

Peculiar effects of alphabetization were also the subject of 2927: Alphabetical Cartogram.

#2790: Heat Pump

June 16, 2023



MANUAL HEAT PUMPS ARE SUCH A PAIN.

If I'm not going to upgrade to a powered one, I should at **LEAST** stop leaving the door open so often.

Explanation

A heat pump is a system which uses a refrigeration cycle to transfer heat from a relatively colder area (typically outdoors) to a relatively warmer space (usually the interior of a building). Such a system works by compressing a refrigerant gas in the warmer space. Gases tend to warm when compressed, and this allows heat to flow from the refrigerant into the surrounding air, which causes the refrigerant to condense into a liquid. This liquid then flows to external coils where the pressure is low enough that it can evaporate, causing the refrigerant to cool, which allowed heat to flow into the refrigerant from the cool environment. This gives the warmer space a constant source of heat, and the only energy cost is what's required to run the compressor.

In this comic, Cueball has a manual heat pump, which appears to operate on the same principle, but uses only a bellows-type container (presumably filled with refrigerant), and is powered only by his own muscles. The strip denotes the warm area with light red coloring, and the cooler outdoors with light blue. When he carries the container outdoors, he allows it to expand, causing it to become colder than the surroundings (indicated by it becoming a darker blue). He then waits until it warms to near the surrounding temperature (the blue becomes less intense), and carries it inside, where he physically presses the container together. This causes the gas in the container to become hotter than the room (denoted by it becoming a darker red), and it's indicated to be radiating

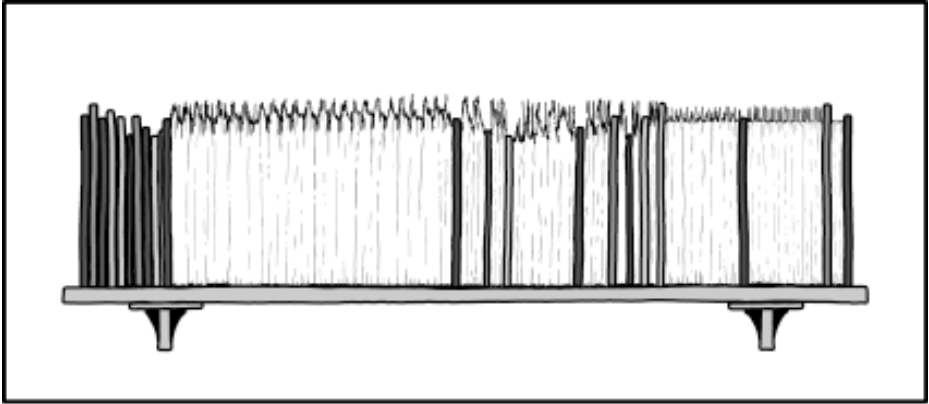
that heat into the room, which is the basic purpose of the whole exercise. The final panel shows him carrying the bellows outside, presumably to repeat the whole cycle.

While this design is theoretically possible, and is a fun illustration of how heat pumps work, it obviously wouldn't be practical in real life (as suggested by the caption). This is true for a number of reasons. First, the pressure required would be difficult for a human to exert with their bare hands. Even if they could do so, they would quickly tire of the exertion, and be unable to sustain the process for very long. The person would need to hold the container shut while it was transferring heat to the environment, which would take significant time, particularly since the container doesn't have much surface area to transfer heat. Depending on the refrigerant, the container could become dangerously hot and/or dangerously cold, or at the very least, unpleasant to hold directly. And the person is physically moving both the container and their own body in and out of the house on every cycle which a) involves a great deal of unnecessary effort and b) means that the person has to spend a large amount of their time outside in the cold. Even if particularly strong and determined person tried to warm a house this way, with no regard for efficiency, the air transfer resulting from going in and out through the door would probably exceed the amount of warming on each cycle, meaning that it wouldn't warm the house significantly. This is lampshaded by the title text, which implies that Cueball leaves the door open some of the time, which would undo nearly all of the benefit of this

process. The logistics of opening and shutting a door when both hands are occupied is also unexplained.

#2791: Bookshelf Sorting

June 19, 2023



BOOK PEOPLE HATE SEEING BOOKS SORTED BY
COLOR, BUT IT TURNS OUT THEY GET *WAY* MORE
ANGRY IF YOU SORT THE PAGES BY NUMBER.

Of course, I sort all my bookshelves the normal way,
alphabetically (by first sentence).

Explanation

Some people like to sort their bookshelves by the visible color of the book's spine, for example by hue to create a rainbow effect. This is pleasing to the eye, but may be unhelpful when trying to find a specific book. Literary enthusiasts (AKA "Book People") frequently dislike this system, because it emphasizes appearance at the expense of making books easy to find. On a philosophical level, treating books as decorations, rather than reading material, upsets many purists. "Book people" are more likely to have a practical system for arranging their books, either by category, genre, title, author name, or some combination of those. For a large library, a more rigorous organizational scheme such as the Dewey Decimal Classification might be used.

Unfortunately, Randall has found a much worse method of book organization - instead of sorting the books as discrete units, he has sorted their individual pages by number. This would require physically separating each book into its individual pages, and then organizing them into groups by page number. This effectively destroys every book, and requires anyone trying to read them to laboriously find each individual page (among many pages of the same number), and then replace it in the correct space after reading. Adding a new book would require individually placing potentially hundreds of pages. Where pages are not numbered, finding their place would be nearly impossible.

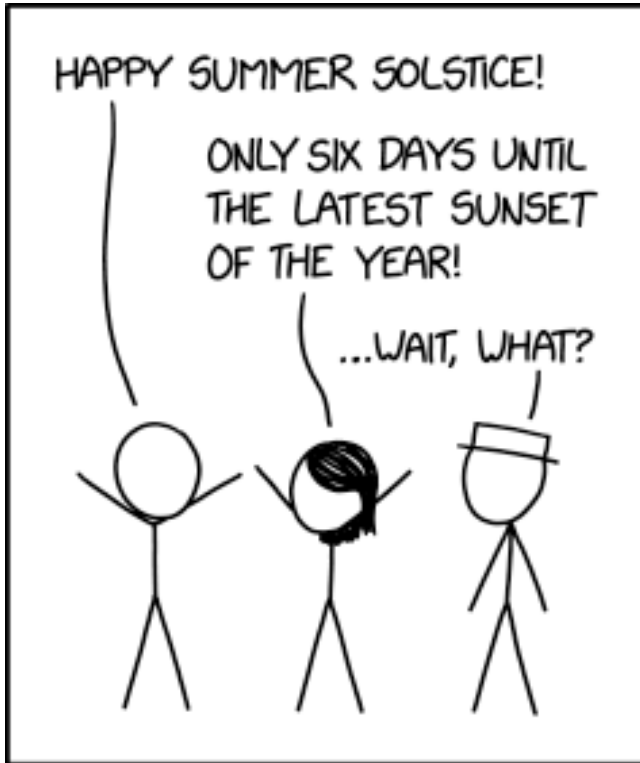
From the picture, Randall's system appears to work by absolute physical page count, including the front and rear covers as 'pages'. All the front covers are on the left side, then the first internal leaf of each book (counted as the second page), then the second internal leaf, etc. This produces repeating patterns of taller and shorter loose-leaf pages, echoing the proportions of each cover, having gathered together a page of the same position in each different book. The back covers are mixed in to whatever group falls after the last internal leaf from the same book, and so are intermixed with pages from longer books. The left-most front cover matches the right-most back cover, the second front cover matches the 2nd-to-last back cover, etc. with the last of the front covers matching the first of the back covers. At the end, there are only the last pages of the longest book left, now all uniform in size, and its rear cover.

The caption claims that "book people" get way angrier at this system, likely because it involves physically destroying books, rendering them almost unreadable. People with a strong affinity for books are often upset at volumes being treated with such disrespect.

In the title text Randall claims he sorts his bookshelf alphabetically, but by the first sentence. He describes this as "the normal way", even though the typical practice is to sort books either by title or author. Some books do have very well-known first lines, so sorting by first line could be used to demonstrate a level of literary sophistication on the part of the bookshelf owner, but could hardly be considered "normal".

#2792: Summer Solstice

June 21, 2023



WHEN I FINALLY FINISH BUILDING
MY GIANT ENGINE CAPABLE OF
SHIFTING THE EARTH'S ORBIT, THIS
IS THE FIRST THING I'M FIXING.

Then I'll start work on my lunar engines to line the Moon up with the ecliptic so we can have a solar eclipse every month (with a little wobble so they're not always on the equator.)

Explanation

This comic was released on the day of the summer solstice in the Northern Hemisphere.

The summer solstice occurs when one of Earth's poles has its maximum tilt toward the Sun. Although the summer solstice is the longest day of the year for that hemisphere, the dates of the earliest sunrise and latest sunset differ by a few days. This is because of two different effects. First, Earth's axial tilt means that at some points in the year, the Earth is slightly ahead in its total rotation, whereas at other parts it is behind. Second, Earth orbits the Sun in an ellipse, and its orbital speed varies slightly during the year. These two effects combine to give the Equation of time, which relates variable solar time to steady clock time. The two have competing effects near the summer solstice, with the axial tilt making the days later and the orbit making days earlier. The axial tilt is the faster changing of the two at the summer solstice, so it wins out, meaning that sunsets are still getting later for a few days after the solstice, despite the days getting shorter. White Hat, a layman not aware of this correction, assumed that the latest sunset would occur on the summer solstice.

Similarly, the earliest sunrise already happened before the solstice. This is given since the day (time the Sun is over the horizon) was longest on the solstice. Still, the Sun will set later for the next six days, meaning that during those six days, the Sun will rise later than previous days by an

even greater margin to make the days get shorter after the solstice.

The caption says that Randall is working on a giant machine capable of adjusting the Earth's orbit. Once finished, the first thing he will use it for is to fix this discrepancy, so the longest day will also have the latest sunset and earliest sunrise. This could be accomplished by either making Earth's orbit circular and removing the axial tilt (which would eliminate the solstices), or trying to balance the orbital eccentricity with the axial tilt, making the solstices match the days of closest or furthest distance from the Sun (perihelion or aphelion). This "fix" would avoid confusing people like White Hat.

The title text discusses his next plans for increasing the number of solar eclipses from 0-1 each year to one each month. Solar eclipses occur when the Moon is directly between the Sun and Earth. Because of the tilt of the Moon's orbit to the ecliptic (the plane of the Earth's orbit, as sort of depicted in 1878: Earth Orbital Diagram), most of the time when the Moon is between the Sun and the Earth they're not in direct alignment, so the Moon's shadow misses the Earth and we don't get an eclipse. Randall's engine will shift the Moon's orbit so it's not tilted so far and we get eclipses every month. But if it were exactly aligned with the ecliptic, eclipses would always be near the equator, so he'll leave a little wobbling so other areas will get eclipses too. Randall thinks solar eclipses are extremely cool, as noted in 1880: Eclipse Review, and would prefer that some of the eclipses be visible from where he lives. He just had one six years ago

(2017), and just got another (2024), but after that there will not be any eclipses over mainland USA for many years.

#2793: Garden Path Sentence

June 23, 2023



Arboretum Owner Denied Standing in Garden Path Suit on
Grounds Grounds Appealing Appealing

Explanation

In a garden-path sentence, the initial attempt to parse its beginning leads to the wrong meaning, causing confusion when the sentence is completed. A classic example of a garden path sentence is "The old man the boat." This seems like nonsense when "the old man" is parsed as a noun phrase, but when "the old" is parsed as a noun, and "man" as a verb meaning "to operate", the sentence means "The old people operate the boat."

Possible grammatically correct interpretations of the sentences in this comic are:

There was a court case regarding green walkways. The case was resolved with a sentence relating to an olive garden path. That sentence was vacated (cancelled) by a judge. That judge was flying an airplane. The airplane struck multiple birds. The plane overturned, but righted (turned right-side-up) and landed safely.

After (bird strikes)1, (judge)2, (who ordered)3 (olive garden-path sentence)4 in (case of green walkways)5 (vacated)3, (overturned but rights and lands safely.)2

This interpretation is backed by the images below the headline on the depicted newspaper which show an airplane and a map with apparently a flight path with two markings in between.

Another way to break it down is, "After [the] bird strikes, [the] judge... [is] overturned, but [she] rights and lands

safely." And she was "[the] judge who ordered [that the] olive garden-path sentence" (the legal sentence concerning a path in an olive garden) "in" (what is known as) "[the] Case of [the] Green Walkways [be] vacated."

A third way is: "The stuff in this article happened after a bird hits a judge's plane where they ordered an "olive garden path" punishment in a court case about green footpaths and is now ON their empty plane which then overturns but then turns right and lands in a safe manner."

This comic also pokes fun at newspaper headlines, which typically have minimal punctuation or articles and use only capital letters, leading to such ambiguities.

For another valid parsing of the sentence, here are some explanatory notes that aid in understanding:

- A criminal court case occurred involving green-colored walkways.
- The sentence handed down in the case involved a specific walkway (a garden path) and a specific shade of green (olive).
- A certain judge had ordered that the sentence be vacated (a legal term meaning undone or expunged).
- That judge was recently piloting a plane which, due to being struck by birds, overturned.
- The judge righted the plane (turned it right-side-up) and landed safely.

A mostly similar, but slightly more comical interpretation (though less likely for a newspaper headline) can be:

After (a) bird strikes, (the) judge ... (as above) (is) overturned, but rights and lands safely. In this case, the judge is standing, a bird strikes her and she is overturned, but she manages to right herself and land safely on the ground (not banging her head, for instance).

Another way of diagramming this (where noun phrases are in parenthesis and verbal clauses in brackets) would be:

Certain combinations of words in the sentence are particularly easy to parse incorrectly. For example:

- "bird" the headline is in all caps so this could be an avian but could also mean a person with the name of Bird such as Larry Bird the basketball player.
- "bird strikes judge" can be interpreted to mean that a bird deliberately hit the judge with an appendage or weapon. If bird is a person or other worker, the phrase might mean a labour dispute in which Bird is withdrawing services
- "Olive Garden" is the name of a restaurant chain, and "ordered Olive Garden" could mean "placed an order for food from Olive Garden"
- Olive Garden could be a person who was the subject of the case in question
- "Garden path sentence" is a type of (written language)

sentence

- "Green" could be referring to "green" initiatives, environmentally-friendly practices being used or to the color green, rather than to a park area
- "in case of" can mean "in the event of" (e.g. "in case of emergency, break glass")
- "vacated" and "overturned" can both mean "undone" in a legal context, and "rights" can refer to legal or constitutional rights

Ignoring the pictures showing a plane and flight path and only focusing on the headline, it could also be interpreted this way:

- "After bird strikes judge", "overturned but rights and lands safely": an avian creature flew into the judge, and as it bounced off it was upside-down, but it managed to recover in time to go right-side-up to land nearby.
- "case of green walkways", "olive garden path sentence": There was a case about green walkways, and the ruling was for an olive garden path (or it is dubbed the "Olive Garden path sentence" for the restaurant chain, because it is strongly linked to the chain - either they wanted this sentence as it benefits them or the chain is notorious for it).
- "judge who ordered", "vacated": The aforementioned judge is known to people for ordering that the sentence be vacated (perhaps this was highly controversial), thus making this event significant enough to warrant a headline.

If one focuses on the word "judge", many of the phrases relate to legal proceedings, making the parsing of the sentence especially difficult:

- "strike": to remove or delete from a legal document and especially from the record of a trial
- "order": a direction issued by a court or a judge requiring a person to do or not do something
- "sentence": punishment assigned to a defendant found guilty by a court
- "case": a civil or criminal proceeding at law or in equity
- "vacate": to legally annul, set aside, or render void
- "overturn": to disagree with a decision made earlier by a lower court
- "rights": powers or privileges held by the general public as the result of a constitution, statute, regulation, judicial precedent, or other type of law

Furthermore, the word "lands" can have two meanings:

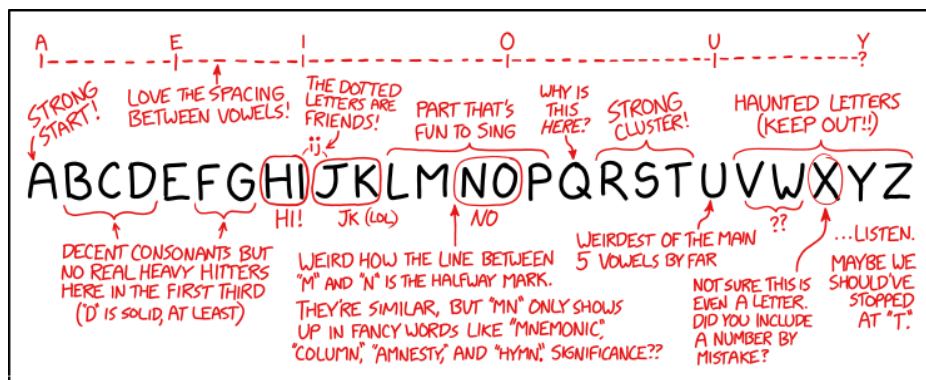
- The present simple variation of "to land": in the context of an airplane, to come down through the air and alight on the ground
- The plural of "land", a common issue in legal proceedings

The title text is also an example of a garden path sentence. The meaning is probably the following: Arboretum owner, [who was] denied [legal] standing in [the] garden-path [law]suit on grounds (the reason) [that

the garden] grounds [are] appealing, [is] appealing [the ruling]. Alternatively: Arboretum owner, [who was] denied [legal] standing in [the] garden-path [law]suit on grounds (reasoning) grounds (why it was denied), [is] appealing appealing [the ruling].

#2794: Alphabet Notes

June 26, 2023



DESIGN NOTES ON THE ALPHABET

Listen, you're very cute, but if you rearrange the alphabet to put U and I together it will **RUIN** the spacing!

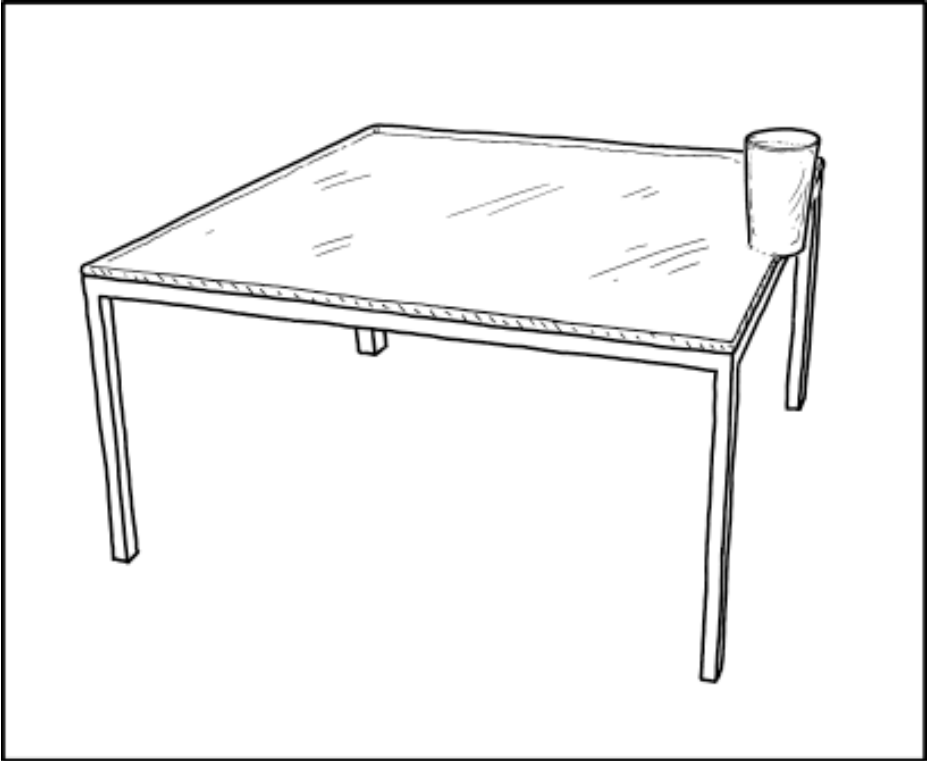
Explanation

This comic is Randall's "design notes" for the English alphabet. The comic lists the A-to-Z alphabet, in black block letters, from left to right. At the top, Randall lists the vowels and appreciates how they are spaced. Interestingly, there are either three or five consonant letters between every consecutive pair of vowel letters in the alphabet. Forming these supposed design notes are many red annotations.

The title text jokes about the pick-up line "If I could rearrange the alphabet, I'd put U and I together.", where the letters U and I are pronounced like the pronouns "you" and "I". It is such a corny act of flirtation that any recipient of it could easily have a rejection (or a flirty acceptance if they so wish) ready to respond within an appropriate vein. As well as reflecting the diagram's noted preference for well-spaced vowels, it might be presumed that anyone (unironically) using the "U and I" line might be left dumbfounded at the rather technical nature of the riposte. This pickup line was also the subject of 1069: Alphabet. The word "ruin" also contains the two letters next to each other, which rather subverts the idea that putting them together results in something cute. Alternatively, the distance ("spacing") between the flirts would change ("be ruined") if they got together, subverting the meaning of "ruin" in a more positive way.

#2795: Glass-Topped Table

June 28, 2023



THE LEAST POPULAR ITEM AT MY FURNITURE STORE
IS PROBABLY THE TABLE WITH A DECORATIVE DRINKING
GLASS BUILT INTO THE EDGE OF THE GLASS TOP.

You can pour a drink into it while hosting a party,
although it's a real pain to fit in the dishwasher
afterward.

Explanation

This comic is a play on the multiple meanings of the word 'glass'. "Glass-topped table" usually means the table top is made from the material glass, but in this comic the phrase further represents a table with a glass surface where surface has been "topped" with a drinking glass. Notably, the glass is part of the table top, merged with the regular glass surface so that the glass can not be lifted off the table. This would thus require the use of a straw to drink from it, or the lifting of the entire table.

Furthermore, the otherwise normal-looking drinking glass looks like it has been placed over (or has 'walked' to) the edge of the table and is about to fall off. This could make anyone unfamiliar with the table likely to automatically reach out for the glass to prevent what appears to be an imminent disaster. This could have unfortunate consequences, since the glass is not independently movable without shifting the entire table. Assuming the person does not hurt their hand or arm from the unexpected load as they take the strain through sheer reflex or by shattering the glass in the attempt, they may successfully move the glass and entire table to cause other things on/adjacent to the table to be toppled/struck sideways.

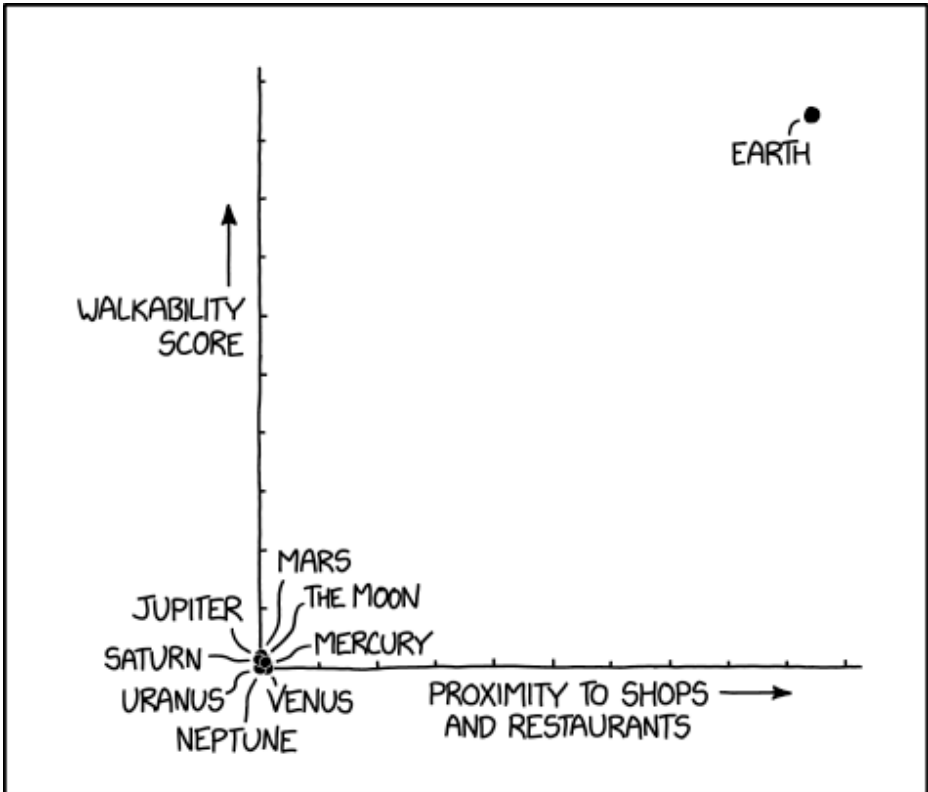
It is not certain if the advertisement for this item makes this configuration clear. By its name alone, buyers might expect to get an ordinary table with a glass surface, but few of them would be interested in buying one when

they discover the extra glass attached[citation needed] and the caption says this is the least popular item in their furniture store. In a web-page/catalogue picture, the glass would just look like part of the scenic depiction presentation of the table, albeit a weird one. It is not unusual that a table in a commercial or an in-store display would feature glasses or other accessories artfully placed upon it, to give it a sense of scale and contextual use, but the dissonance of the 'carelessly' positioned glass would work against the usual advertising pressures employed. Anyone who still ordered the table, without establishing the true nature of its permanent feature, is also then likely to complain and negotiate a refund/replacement (negating whatever sales were actually made) and write bad reviews (discouraging others from even looking at the product).

The title text adds to this by saying it would be difficult to put the glass in a dishwasher, since you would need to bring the table with it. There are dishwashers big enough to fit tables, but they are not for regular households. And that won't make moving the table any easier. Cleaning the glass after a drink would thus have to be done by hand, and the water in the glass has to be sucked out, mopped up or drained by inverting the whole table (or entire top, if detachable) in a non-damaging way.

#2796: Real Estate Analysis

June 30, 2023



AFTER DOING A REAL ESTATE ANALYSIS,
I GET WHY THIS PLACE IS SO POPULAR.

Mars does get a good score on 'noise levels' and 'scenic views,' but the school district ranking isn't great; the only teacher--the Perseverance rover--is too busy with rock samples to teach more than the occasional weekend class.

Explanation

This comic shows a chart ranking locations in our solar system (the eight currently recognised planets and Earth's own moon) along two scales: their walkability and their proximity to shops and restaurants. As this is a "real estate analysis", this comic mocks real life "real estate analyses" for people who are looking for a new home. Walkability measures the ease of walking as a form of transportation in an area (often related to how urban that area is), and is measured by metrics like the 100-point walk score, with higher numbers representing easier and safer walking. Proximity to commercial shops and eating establishments can likewise be a factor for potential residents looking for a convenient living environment. While no units are provided, proximity can be defined as a number that increases with decreasing distance.

Earth is rated as highly walkable, probably because humans can walk on much of its surface without immediate & continuous existential need for environmental survival gear (so far), and due to the gravity on its surface. Earth also rates high on the "proximity to shops and restaurants" scale because its surface hosts all commercial establishments known to humans; most businesses are within a few building stories of the surface, though some "shops" on airplanes are up to several kilometers above it.

All other locations are rated as completely unwalkable,

and remote from any shops or restaurants. The next closest body, the Moon, typically around 384,400 km away from Earth, is about five orders of magnitude further from shops and restaurants than anywhere on Earth. (A dozen people have actually walked on the Moon, more or less, but none have actually walked to the Moon, or to wherever else they may want to go from there.) Venus is 108 million km away while Uranus is 2.9 billion, so all these bodies' clustering near the origin on the proximity scale masks a large difference in accessibility. The gas giants Jupiter and Saturn are assessed marginally higher walkability scores than the solid Mercury (where temperatures are extreme, but do briefly pass through the range survivable for humans as the planet rotates); maybe their less-hostile (and, in the case of Ganymede and Titan, physically larger) moons are taken into account here.

Based on Earth's high score on both metrics, Randall makes the claim "I get why this place is so popular". Most humans would agree with Earth being preferable (no human is known to have permanently inhabited any celestial body besides Earth), but would be more concerned with local differences in livability.

Additionally, the chart also displays the importance of choosing the right scales and data for data representation, because not only does the chart provide no information at all, as the vast surface of earth is marked at the same point; but it also does not provide sensical data, which can be seen by the chart seeming to show a slightly larger proximity to shops for Mercury and Venus than the

Moon, which is just plain absurd.

Walkability scores on websites such as <https://www.walkscore.com> consider proximity to restaurants, groceries, and shopping (among other factors, such as proximity to parks, schools, and culture and entertainment venues), so it would be fairly unusual for a location to score high on walkability but low on proximity to shops and restaurants, or vice versa.

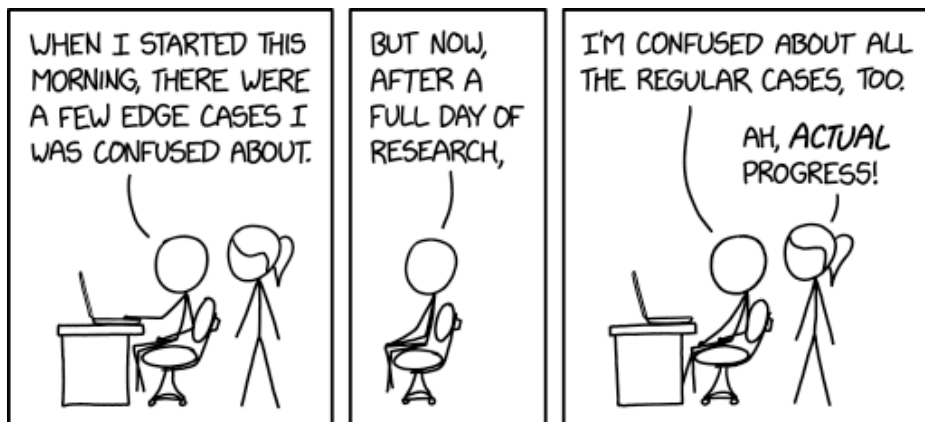
The title text comments that Mars did score high on the 'noise levels' and 'scenic views' scores. Generally, lower noise levels help maintain a calm and relaxed lifestyle, and are therefore a desirable quality for real estate. Due to it having a thinner atmosphere and (almost) zero sources of manmade noise, Mars is incredibly quiet (though not entirely silent). However, this extreme lack of noise may turn out to be detrimental to human wellbeing. Access to scenic areas is also generally seen as a positive when assessing property, and the large, barren scenery of Mars has been abundantly documented by the several rovers sent to its surface, resulting in widespread fascination with its serene landscapes (though the ever-present dust, and the need to deal with it, mars the serenity somewhat). Again, though, the sheer emptiness of the landscape might turn out to be a negative rather than a positive.

It then states the 'school district' ranking (proximity to a good schooling system, which is also desirable, especially to families) is rather poor on account of there being only one available teacher, which turns out to be the

Perseverance rover. Perseverance is (at the time of this comic's publication) a still-active Mars rover whose main purpose is to examine minerals from Mars' surface and scan them for signs compatible with ancient life: while it could hypothetically serve as a teacher (using its memory banks as teaching material, for instance), doing so would greatly interfere with its main mission if done regularly. This problem is recognised, in that it is mostly being too busy with its rock samples, yet it can apparently spare the occasional weekend tuition slot.

#2797: Actual Progress

July 03, 2023



Slowly progressing from 'how do protons behave in relativistic collisions?' to 'what the heck are protons even doing when they're just sitting there?'

Explanation

An edge case is a situation, often in software engineering but also in other domains, that is rare and may need special handling and does not perform the way most of the situations do.

At the start of tackling a complex problem, somebody may come up with a simplified interpretation of it, see it as simple, and implement and even deploy a system that uses their interpretation. These partial (incorrect) and ingeniously useful solutions are called heuristics in software engineering. If the developer is unaware that their formation of the problem is incorrect, they may happily dive into edge cases hoping to hash them out and resolve them, only to uncover that the very underpinnings of their possibly-live system are based on false perceptions or logic and then often even be at a loss as to how it is working at all.

Similar issues can arise in the physical sciences. A few pieces of experimental data, taken under novel conditions, may not fit the currently-accepted model. Attempts to reconcile them may lead to the discovery that many other pieces of data, which previously had been taken to confirm that model, lead to problems when they are examined carefully. Ultimately, a better, more generally applicable model may be found. For example, Mercury's orbit isn't consistent with strictly Newtonian mechanics, a problem that resulted in many theories but which was ultimately resolved by Einstein's

Theory of General Relativity. Extremely careful measurements of other planets' orbits would have revealed that they, too, don't conform to Newtonian mechanics; the effect is general, but most easily observed with Mercury because of its relative proximity to the sun. (More commonly, the few pieces of data that don't fit may be found to be invalid, a result of experimental error under the novel conditions. "They laughed at Galileo... but they also laughed at Bozo the Clown.")

At this point it may be the case that the developer is actually working on a cutting-edge research challenge, unaware that this is the case, and the problem space they have to grapple with is one that is actively being worked on, yet nobody has yet completely addressed. In 1425: Tasks, a naive boss asks an engineer to perform two tasks that the engineer gives wildly different estimates for the developmental timespan. Before the easy accessibility of research papers it was much less obvious when this was or was not happening. And today, when many historically very hard problems have many more well-known solutions, and many of the very hard problems that have been intractable in the past are demonstrating aggressive progress that anyone can step in and review, the situation is quite different and much more tangible.

Another quite common software engineering situation like the comic is when working with a codebase that has been rushed to market without organizing and modeling its underlying concepts well: "spaghetti code". At first one may think they can enter the software and simply

patch a fix, but past similar patches have made the parts needlessly intertwined and baked any heuristics in in an unmaintainable way.

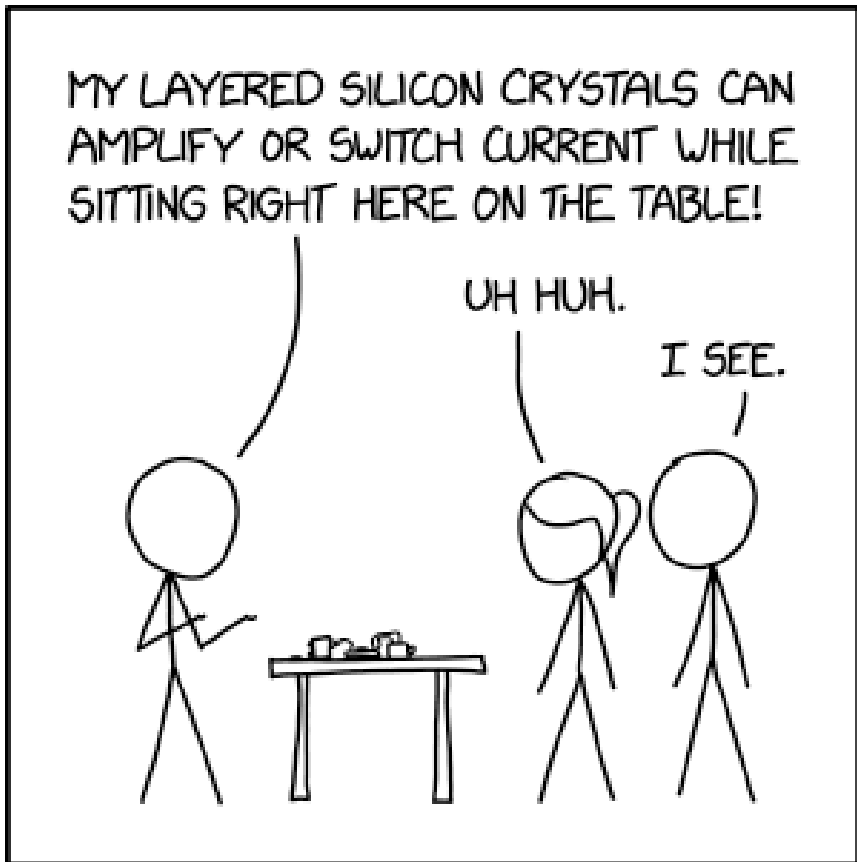
The joke regarding “actual progress” is both sarcastic and possibly referring to how the most progress is made on a problem when its general structure and underpinnings are addressed directly: when it is better understood and its root causes engaged. This appears ironic when it means breaking apart the solution to unusability before rebuilding a better one, which is usually what happens here; this is called refactoring and is analogous to taking everything off the shelves of a slightly-messy room, making it very messy, before putting everything back in a new mess-free organization. In both situations if your new solution has a crucial mistake you end up with a much worse situation.

The title is similar to 1906: Making Progress which shares a similar structure of “I Started... But now, After...” but ends up with problems listed in a spreadsheet rather than more confusion.

The title text may have been partially inspired by the PBS Spacetime episode “Did AI Prove Our Proton Model WRONG?” released twelve days before this comic, which discusses how physicists don't have a proven accurate model for the internal structure of a proton at rest and that having an AI analyze collision data resulted in a model significantly different from human-made ones.

#2798: Room Temperature

July 05, 2023



NO ONE IS IMPRESSED BY MY DISCOVERY
OF ROOM-TEMPERATURE SEMICONDUCTORS.

They're also refusing to fund my device that
demonstrates uncontrolled hot fusion.

Explanation

In this comic, Cueball presents a room-temperature semiconductor, consisting of layered silicon crystals. He enthusiastically describes the properties of his "discovery", namely that it can be tweaked to amplify or switch the flow of electric currents, but his audience is not impressed. This might be because silicon crystal semiconductors are already widely in use as a key component of electronic systems. Silicon semiconductor manufacturing is, in simplest terms, adding materials to a flat wafer made of silicon crystal, often in a process that adds an entire layer of material, then removing the unwanted areas through various etching methods. Development of these processes began in the 1960s.

It appears that Cueball has confused semiconductors with superconductors - materials that have no electrical resistance, meaning the flow of electrons is not slowed down at all (resistance can be thought of as the electrical equivalence of friction). Superconducting properties are extremely desirable since they allow for the lossless flow of electric current, as opposed to regular conductors like copper which have a low but non-zero resistance so the electric current decreases over time and distance, and this may also lead to superconductors having interesting magnetic properties. However, the known superconductors only work at extremely low temperatures close to 0 K, so their practical use is very limited. The discovery of superconductors that work above the boiling point of nitrogen (77 K or -196 °C) was

a big deal because it meant that relatively cheap liquid nitrogen could be used as coolant rather than liquid helium. The comic probably references the recent controversy around alleged superconducting properties of carbonaceous sulfur hydride and nitrogen-doped lutetium hydride under extreme pressures. A team at the University of Rochester published two papers in the journal *Nature*, the first for C-S-H at 267 GPa which was later retracted after failed attempts at replication, and the second for Lu-N-H at just 1 GPa, which was later replicated. These pressures are too high to be practical for most engineering purposes, but the discoveries are still progress in the study of superconductivity. The discovery of a superconductor at standard temperature and pressure would be extremely surprising and could revolutionize electricity transmission, among other things, and dramatically reduce the cost of technologies like magnetic levitation and high-resolution nuclear magnetic resonance imaging.

In the title text, Cueball talks about a device that produces “uncontrolled hot fusion” which is also not met with enthusiasm. Again, this is likely due to the fact that it has already been discovered and used - in the form of hydrogen bombs. This is likely why no one wants to fund the device - not only is it not novel, but it is extremely dangerous; though clearly he also hasn't excited those people who typically want something dangerous. Controlled hot fusion could be useful as an alternative power source to nuclear reactors (which currently use nuclear fission); however, current







implementations still require more energy than they create. Cueball probably confused this with cold fusion, i.e. nuclear fusion that takes place at temperatures much, much lower than the millions of degrees required for "regular" hot fusion. There are reputable ways of achieving this (all of which require vast amounts of energy), but "cold fusion" has become the epitome of bad science since two scientists claimed, with much media attention, to have achieved cold nuclear fusion by doing an electrolysis of palladium in heavy water. The results could not be replicated by other scientists and the experiment was widely criticized for its many flaws, most importantly that the only indication of nuclear fusion was excess heat, with no detection of actual fusion byproducts.

High(er)-temperature super-conductivity might be the key to more effortlessly initiating and maintaining low(er)-temperature fusion, through very concentrated magnetic fields, but so far their respective temperature ranges are too different to use them in combination, and whether this will ever be possible remains subject to speculation.

It should be noted that both "discoveries" presented in the comic were in fact very big and important discoveries back in their day. The proposal that nuclear fusion is what powers stars earned Hans Bethe the Nobel prize in Physics, and semiconductors are what allow modern electronic devices to be so small, as their properties make it possible to selectively steer the flow of electrical current, even over an extremely small area.

#2799: Frankenstein Claim Permutations

July 07, 2023

CLAIM	NOTES
BY MS  "NO, THE MONSTER IN MARY SHELLEY'S BOOK IS UNNAMED. FRANKENSTEIN IS THE DOCTOR WHO CREATED HIM."	THIS IS THE NORMAL CLAIM
BY MS  "NO, THE MONSTER IN MARY SHELLEY'S NOVEL IS NAMED FRANKENSTEIN."	ALSO COMMON, AND NOT WORTH GETTING MAD ABOUT IMO
BY F  "NO, FRANKENSTEIN IS THE NAME OF THE AUTHOR. THE MONSTER MARY SHELLEY CREATED IS UNNAMED."	AT A GLANCE THIS COULD PASS FOR ONE OF THE NORMAL CLAIMS
BY ?  "NO ONE KNOWS WHO WROTE THE NOVEL ABOUT DOCTOR MARY SHELLEY CREATING THE MONSTER FRANKENSTEIN."	I WOULD READ THIS BOOK
BY ?  "NO, FRANKENSTEIN IS THE NAME OF THE DOCTOR. THE MONSTER HE CREATED IS MARY SHELLEY."	FULLY CHAOTIC
BY F  "NO, THE DOCTOR WHO CREATES MARY SHELLEY IN FRANKENSTEIN'S NOVEL DOESN'T HAVE A NAME."	

When I began trying to form a new claim by stitching together these parts in such an unnatural way, some called me mad.

Explanation

Frankenstein is an 1818 novel by Mary Shelley about a young scientist named Victor Frankenstein who creates a sapient, humanoid lifeform through an unorthodox experiment, and then rejects his creation, which eventually turns on him. The novel is a classic in both the horror and speculative fiction genres, and has been argued to represent the first major example of true science fiction in literature. The lifeform he creates is never named in the original novel, only being referred to as "the Creature".

In the two centuries since the novel's publication, the story and its characters have been adapted and reused in various forms, and the term "Frankenstein" has come to be commonly used to refer to the creature, rather than the scientist who created him. Literary didacts are often quick to point out this error, but are generally ignored, as the name has become accepted, common usage. The debate has become something of a meme. The Creature himself, at one point, refers to himself as effectively being Frankenstein's son, which could imply he wishes to carry the same name; at the same time, Doctor Frankenstein does not treat his creation with such a level of humanity and speaks as if the Creature is completely nameless. To this day the debate continues among literary analysts whether the Creature should remain nameless for these reasons. These disputes have previously been touched upon in 1589: Frankenstein and 2604: Frankenstein

Captcha

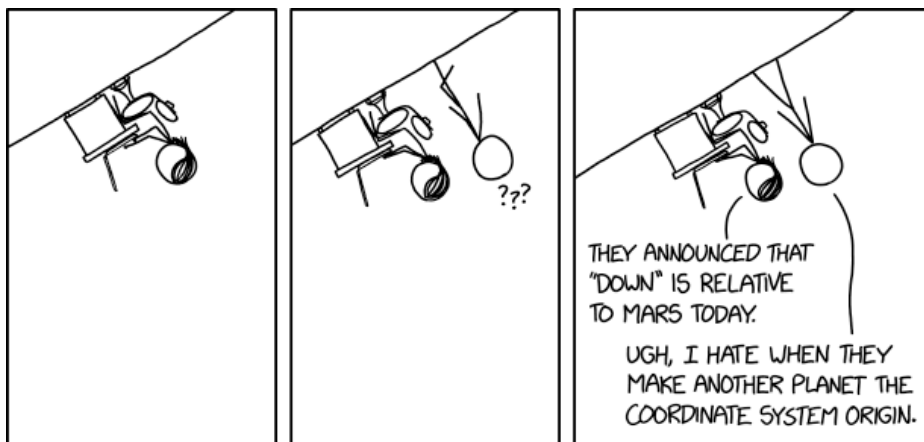
The title text points out that he's "stitching together" various claims to create something new, and people consider him mad as a result. This refers to the notion of Frankenstein's creation having been stitched together from dead bodies, and Dr. Frankenstein himself being denounced as a madman. It should be noted that these perceptions come from later adaptations (most notably the 1931 film) rather than the original novel, but have become closely associated with the Frankenstein mythos. Following similar meta-textual logic, the title "Frankenstein Claim Permutations" is a double entendre, meaning both (1) permutations of claims regarding the novel Frankenstein and (2) permutations of claims of a Frankenstein nature (i.e. a franken-claim) in that they are formed by haphazardly joining together different parts.

This comic explores the possible permutations that can be made by matching the names of Mary Shelley, Frankenstein, and '?' (for the unnamed monster) to the positions of author, creator, and monster. The positions are indicated in the drawing by a circle to the left of the book for the author, a box on the left-hand page for the creator, and a labeled picture of the monster lying under a sheet (the traditional image of the monster before being animated) for the monster. Three elements can be arranged in six different ways, as the first element can be placed in any of the three positions, the second in either of the two remaining, and the last in the only remaining space, giving $3 \times 2 \times 1$ options. The same concept was used in 1613: The Three Laws of Robotics, where Randall depicted six possible permutations of the Three

Laws of Robotics.

#2800: Down

July 10, 2023



It's just that I get nervous about heights.

Explanation

The direction that we call "down" is usually defined as the direction in which objects on Earth fall, which, for all intents and purposes, is the same as the direction that points toward the center of the Earth. This direction is therefore relative, as it depends on where you are located in relation to Earth's center, and is different for people in different locations. For example, from an outside viewpoint, the direction of "down" for people in Madrid, Spain is the opposite of the direction of "down" for people in Weber, New Zealand, as these two places are located at antipodal points on Earth.

It is possible to redefine "down" by choosing a different point of reference, such as the center of a different planet, which is the situation shown in this comic. We see Megan seated at a desk, which would be perfectly normal if not for the fact that the scene is shown at a completely unnatural, almost upside-down angle. Megan explains to Cueball that the direction of "down" was redefined to be relative to Mars instead of Earth. Since Mars is located in space many millions of miles away, this means that "down" could potentially be in almost any direction.

Redefining down to be relative to Mars would be impractical for people on Earth,[citation needed] as Mars is constantly moving with respect to Earth; this means that the direction of down will drift over time. Additionally, as Earth rotates once per day, the direction

of down would also experience a 24-hour periodic wobble. It would be very difficult to keep track of this constantly-changing direction. Setting down relative to Earth's center avoids these problems (at least for beings on Earth!), as the Earth's center is static in relation to the motion and rotation of Earth.

Megan does not explain who exactly redefined down, or why they have the authority to do so, but it is most likely some scientific body such as the International Astronomical Union or the General Conference on Weights and Measures, which have the power to make such decisions - for example, the IAU defined planet and dwarf planet in 2006, and the GCWM redefined the kilogram in 2018. In reality, in addition to there being no governing body which determines the direction of down, such definitions are made only when there is compelling reason to, and they work hard to minimize the changes. (For example, the redefinition of the kilogram was done in order to prevent the mass of the kilogram from changing in the future by attaching it to physical constants.) Nonetheless, in the world shown in this comic, redefining 'down' appears to happen frequently enough for Cueball to be frustrated but not fazed by it.

It should also be noted that redefining down does not automatically alter the direction of gravity, which will still act in the same direction it did before. Therefore, it is unclear how Megan or Cueball are even aware of the change in definition, unless they are somehow aware of the comic they are in and "know" that they are oriented at a strange angle.

Cueball mentions that the redefinition of down is a side effect of redefining the origin of their coordinate system. A coordinate system is a way of representing locations in space using a set of numbers, where each number (called a coordinate) measures a distance travelled in one of the spatial dimensions. In order for these numbers to be meaningful, it is always necessary to define a single point as the origin, where all coordinates have the value 0. Locations can then be measured relative to the origin.

For example, a commonly-used coordinate system for Earth is the Earth-centered, Earth-fixed coordinate system, which defines the origin to be Earth's center of mass, and uses three pairs of points on the Earth's surface to define the directions of the three spatial dimensions; this allows any point relative to Earth to be specified as a triplet of three coordinates. Presumably, the coordinate system now used in the comic is a "Mars-centered, Mars-fixed" coordinate system, which would be good for things like launching satellites from Mars, but otherwise not very useful for most Earthly situations.

In the title text, Cueball states that he gets nervous about heights. Height is the distance between two points at different elevations, and elevation depends on which way "down" is - therefore, redefining down also redefines the concept of height. Since down now points toward Mars, and Mars is millions of miles away (about 34,000,000 mi or 55,000,000 km at closest approach), this means that Cueball - and indeed, everyone on Earth - is now standing at a height of about 34 million miles above Mars. While fear of heights is a common cause of anxiety,

it doesn't really make sense for Cueball to be nervous in this instance - usually, when people are afraid of heights, it's because they are afraid of falling. However, gravity still points toward the center of the Earth, so Cueball is in no danger of falling to Mars. The joke is that Cueball is scared solely due to the redefinition of the situation - where previously he was standing on solid ground, now he is "perilously" clinging to the underside of a planet with a 34-million mile drop beneath him.

The only advantage of using Mars as down, is that everyone on Earth agrees on the direction of down, since Mars is so far from Earth that even those on either side of Earth orthogonal to the direction towards Mars, would still almost agree on the down direction.

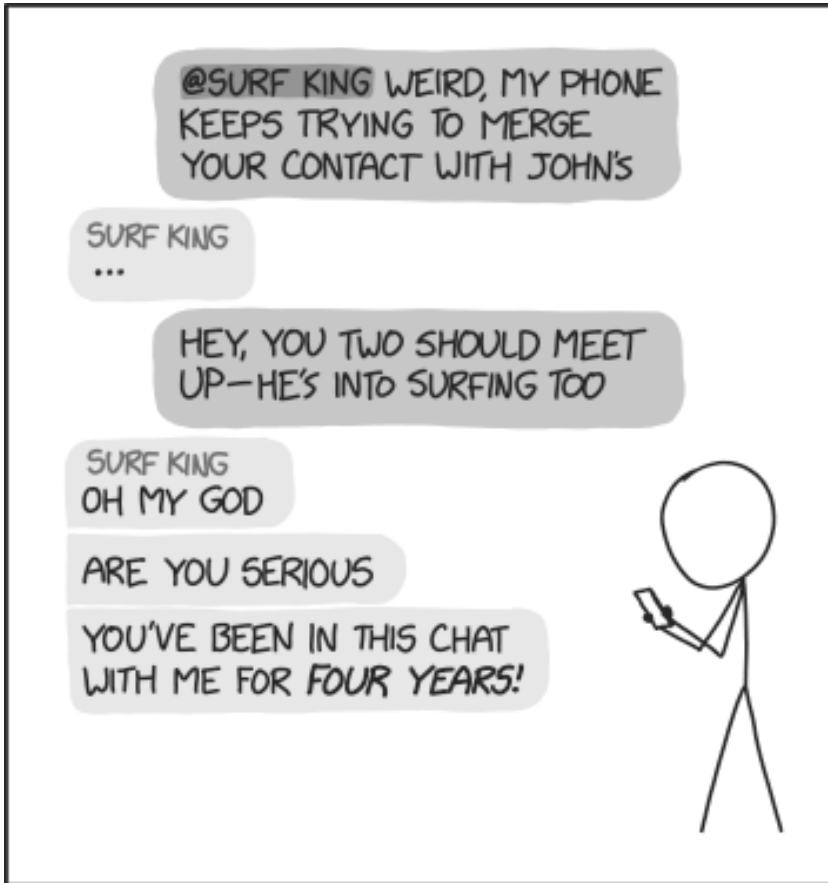
In the 2024 April Fools game comic 2765: Escape Speed, the planet outside of the Crystal Sphere, based on the Click and Drag comic, didn't have it's own gravity, so the spaceship would be pulled towards the Crystal Sphere no matter what side of this planet the spaceship was located. As this made navigating difficult, however, Randall later added gravity to the planet.

The comic could also be a reference to the novel Ender's Game by Orson Scott Card, in which the protagonist, Ender, helps his team to orient themselves in a zero-gravity battle by noting that the directions "up" and "down" are arbitrary in space; he summarizes this with the mantra "The enemy's gate is down". This insight gives his team an anchoring point of reference which makes it easier for them to function in the gravity-less arena. This

aspect of Ender's Game was previously referenced in 241: Battle Room.

#2801: Contact Merge

July 12, 2023



I WONDER WHO HOLDS THE RECORD FOR
ACCIDENTALLY DOING THIS THE LONGEST.

I actually kind of feel like John and Surf King wouldn't like each other, which is a lot to unpack.

Explanation

Cueball is in contact with someone in a some typical text-chat context, who uses the nickname of "Surf King". His phone also knows of a person called John, which seems to be the real name of the same person, although Cueball appears to have been unaware or forgetful of that fact. The humor arises when Cueball mentions this to "Surf King", who is flabbergasted that Cueball is not aware of this fact.

Some algorithm that manages the contact-list has been offering (or trying) to merge the contact details into a single entry, as having the same core details, which intrigues Cueball but without him understanding why. Instead he directs a comment about this to "@Surf King", who apparently did not deign to respond (a typed-out ellipsis as a common shorthand for being rendered speechless, as opposed to the temporary "Currently typing" ellipsis).

Cueball's follow-up comment is clearly prompted by the realization that his 'two' contacts both share an interest in surfing, perhaps having been in separate group conversations with both John and Surf King personae in the interim, and he decides to revisit the issue. But from Surf King's response it looks like Cueball and Surf King have been chatting (indeed, in this specific chatroom) for several years, making it mildly impressive that Cueball apparently never made the connection between his identities in that time.

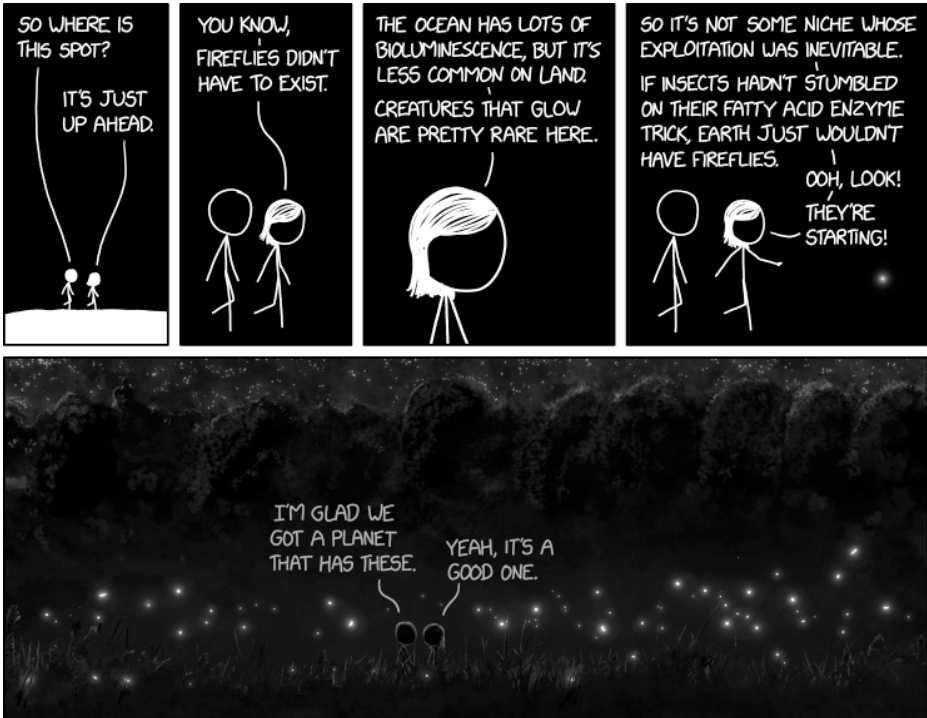
The title text implies that Cueball has had second thoughts about the compatibility of Surf King/John with himself, having picked up further cues from either or both of subsequent chats with him (outside of this particular channel) that reduce the perceived social compatibility. This could be explained by John being far more (or differently) extraverted when interacting via his more sporty pseudonym, or possibly by having subtly changed attitudes and interests over time while not actually using one or other identity to update others' impressions of him. Either of these can be due to his perhaps having let the account of his youth go mostly idle, instead interacting primarily by with the other. In professional contexts, people have been switching to using their given name, whereas people also switch to pseudonyms to protect themselves from harassment or identity theft. It could also simply be that John does not respond well to people like himself, instead having a personality that gravitates to a complementary personality rather than a similar one.

This is another example of Cueball demonstrating extremely nerdy habits. This can possibly be explained by developing different kinds of experiences at a significantly different rates than more extroverted and social individuals due to a much higher proportion of the time and focus in both childhood and adulthood spent doing technical work. Due to this different proportion of experiences, such people can miss normal conversational implications like this, while demonstrating great aptitude in less common scenarios such as engineering. Many see

these kinds of people as the intended readership of the comic.

#2802: Fireflies

July 14, 2023



I feel bad for Earth 2 and their shadowflies.

Explanation

Fireflies are varieties of beetles that emit flashes of light, a process known as bioluminescence. Megan explains that while this ability is not uncommon in ocean-dwelling species, it's pretty rare on land. Presumably, this is because sunlight doesn't penetrate very far under water, so there's evolutionary pressure there to develop a process to generate one's own light. Land animals, on the other hand, have much less need to generate their own light -- even at night there's light from the moon and stars, so nocturnal animals tend to have good eyesight or other enhanced sensory abilities (echolocation, olfaction, etc). It's thought that bioluminescence in fireflies originally served aposematically to ward off predators from larvae, but that it was co-opted as an adult mating signal. There are many varieties of bioluminescent fungus species, and the ecological benefit of that effect is uncertain. Some ocean-dwelling species, such as anglerfish, use their bioluminescence as lures for prey, whilst other creatures use it as camouflage. Yet others may employ such light as warning and/or as mating signals to deliberately reveal (not conceal) their presence. Often creatures with sufficient control of their phosphorescence can even fulfil multiple purposes according to need. These functions are similar to how organisms in more well-lit environments might normally rely upon surface hues (of skin, fur, feathers, scales, etc.) that work more (or less) passively under external illumination. Megan also mentions fatty acid enzymes, presumably a reference to

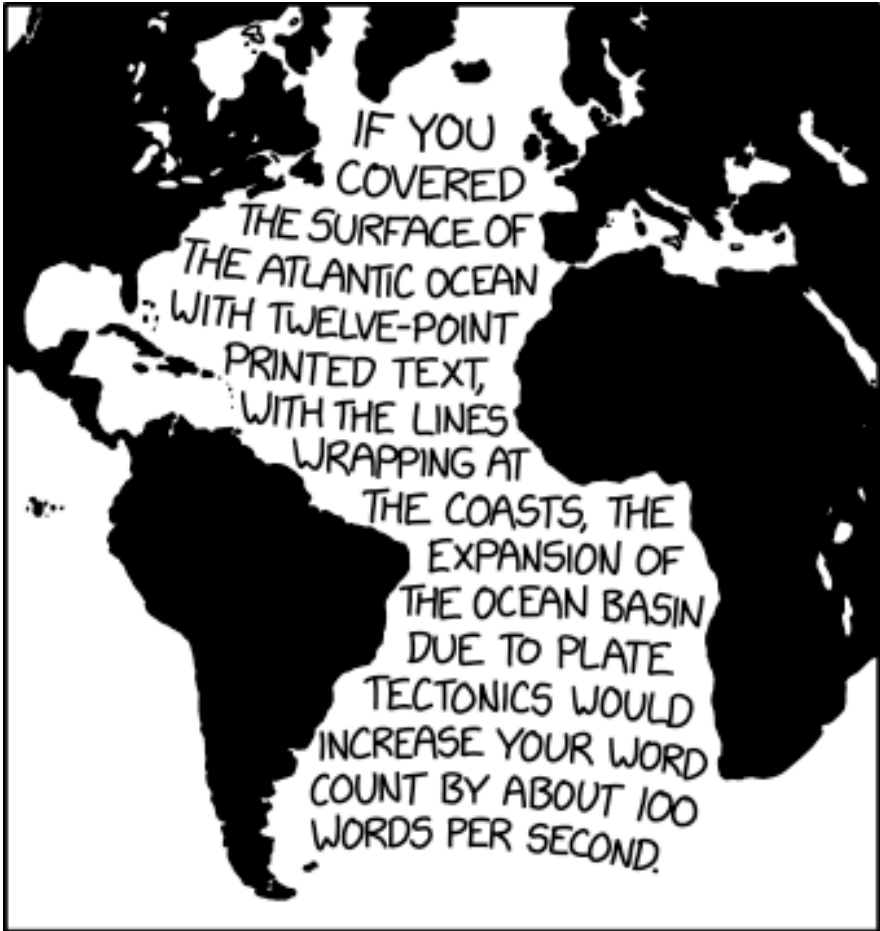
luciferase, a class of enzymes used by fireflies and many other bioluminescent organisms.

While Megan and Cueball are walking towards a field with fireflies, she points all this out and suggests that it was just a fluke that fireflies developed this ability. When they see the firefly display, the two of them agree that we're lucky to be on a planet where this happened. Sadly, the moment may be fleeting as fireflies are going extinct, at least in North America.

The title text suggests that there's an alternate Earth that has "shadowflies", which are presumably like fireflies but cast shadows instead of light, and that this isn't as nice for the people there. Since everything that's opaque casts a shadow[citation needed], this isn't really much of an ability. Possibly Randall's shadowflies have some sort of vantablack-like coating, or somehow create darkness near them beyond merely absorbing incident light (in violation of physics as we understand it). "Earth 2" is the name of an alternate world in the DC Comics universe, but it's unclear if this is the specific world being referred to. A presumably different alternate earth has been mentioned before. Earth 2 may also be a reference to an actual exoplanet which appears very similar to Earth.

#2803: Geohydrotypography

July 17, 2023



MY HOBBY: GEOHYDROTYPOGRAPHY

The Atlantic is expanding at about 10 ppm (points per month).

Explanation

This comic is another entry in the "My Hobby" series of comics.

Plate tectonics is the understanding that the Earth's lithosphere is divided up into separate 'plates', which carry the continents and (in the case of the Atlantic) are slowly moving apart under geological action that mostly drives the respective coastlines away from the deep center of the ocean. Here, Randall explains that if the surface of the Atlantic Ocean were covered in a certain size of printed text (as if its surface were a giant sheet of printed paper, which it is not),[citation needed] the shifting of the continents would increase the amount of text by about 100 words per second.

Randall says that his hobby is geohydrotypography, which is a compound of 'geo' (from the Greek for earth), 'hydro' (water), 'typo' (type, as in printing) and 'graphy' (a descriptive science) - in other words, the arrangement of letters, words and symbols on the water surfaces of the earth. He may mean that he enjoys studying such arrangements, and/or that he likes arranging such text himself.

The title text is a pun on "ppm," which is generally understood to mean "parts per million" (a dimensionless unit of concentration). Here, it instead describes the rate of the ocean's expansion, about 40 millimeters per year, in "points per month." A point in typography is 1/72 of

an inch, or $127/360 \approx 0.3528$ millimeters. The expansion sideways would steadily allow more characters on the first line (and thus intermittently more words, 'unwrapping' the first word seen on the next line) and cascading this effect onto every subsequent line spread out vertically along the roughly 13,000km (depending upon your choice of limits) North/South 'height' of the writing medium.

The exact calculation needs various assumptions. Font families of a given well-defined vertical size/separation can each exhibit varying general widths of character, and be subject to various possible degrees of kerning, depending upon what precise choice of text is made (unless using a strictly a fixed-width font). The spacing between successive lines would need to be chosen. The word that does (or does not) have to be wrapped at the first line-break can affect which groups of words may (or may not) need to wrap on subsequent lines, in a cascading effect that can create almost chaotic changes from just a single reassessment. However, the law of large numbers would likely minimize the effect of this variability, such that an estimate from known averages would yield a result with a very small amount of relative error. It is not known which (ballpark) number Randall assigned as the current word count as of posting the comic.

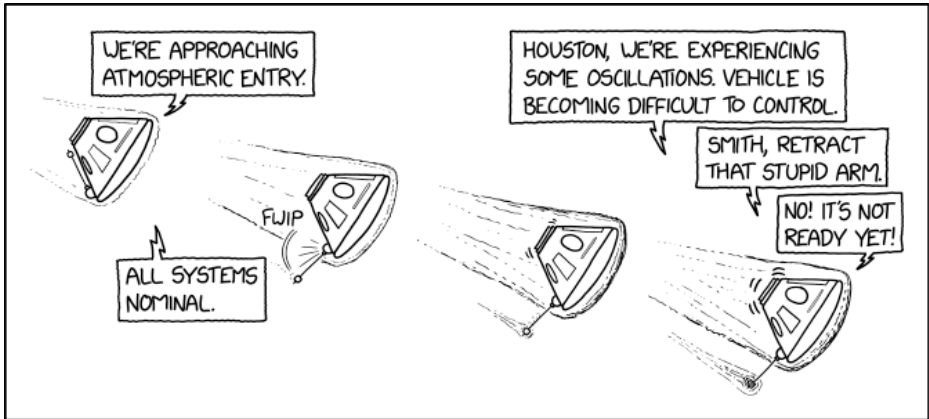
The exact extent of the Atlantic Ocean can also be differently interpreted: where it meets the Southern and Arctic oceans, whether to include bordering 'seas' such as the Gulf of Mexico and Mediterranean and Caribbean

Seas, what to do where the 'text' may have to cross/break-across islands (e.g., the Bahamas, Azores, etc., some of these being treated as Atlantic boundaries with the comic's relatively much larger size of "ocean text"), possibly even whether to track the precise tidal inundations at the coastlines at any particular moment, which would make the resulting word count per second probably fluctuate with the tides (unless high-/low-/median watermarks were actually chosen as standard). All these factors, and more, make it difficult to precisely define the total number of characters (and thus words) that would fit, though the annual increase in the approximate area of the ocean could allow us to assume some approximately greater number of characters (based upon an approximation of their average page-area requirements) which could be divided by the approximate number needed for a general corpus of words (and its spacing) to determine the approximate additional text that could now be added for any given span of time. Knowing Randall, he has used the best approximations that he could find and determined that the possible cumulative errors were not unacceptable.

Note that the text as it appears on the globe in the comic is not 12 point, but instead is close to 1.5 billion point.

#2804: Marshmallow

July 19, 2023



IN RETROSPECT, THE REENTRY MARSHMALLOW TOASTING MODULE WAS A MISTAKE.

The increasing number of graham crackers and chocolate bars in orbit has created a growing risk of Kessler s'mores.

Explanation

This comic shows the atmospheric re-entry process of a capsule similar to that used in the Apollo moon landing program in the late 1960s and early 1970s. This capsule features a fictional Reentry Marshmallow Toasting Module, with a marshmallow on a deployable stick, which is exposed to airflow during reentry.

During reentry, the capsule would presumably be going at orbital speeds, which for Earth are in excess of 8 km/s. This high velocity leads to air in front of the capsule compressing and heating up as it absorbs its kinetic energy (see Atmospheric entry for more details on ways of heating at work). This has the effect of heating the marshmallow. Additionally, reentry heating effects typically look like flames covering the bottom of the reentering object. This is very similar to a common practice on the Earth's surface of holding a marshmallow on a stick over a static fire on the ground, like a campfire, which also heats the marshmallow, improving its taste.

At the start of the panel, the capsule is approaching atmospheric entry, so any aerodynamic forces would not have begun yet. "All systems nominal" is an aerospace phrase that means all systems (including life support, navigation and stability systems) are performing as expected. However, once the atmospheric effects begin then something goes wrong.

Having a long, thin extension to the airflow will disrupt

the aerodynamics, as air starts pushing up against the roasting stick, creating an unbalanced torque that pushes the marshmallow further back into the airflow, rotating the entire capsule. This angular acceleration continues until the aerodynamic design of the rest of the capsule plays a significant factor, rotating the capsule back to its original position, and starting the uncontrollable cycle of oscillations anew. Hence, the astronaut on board reports some oscillations to Houston.

This prompts the unnamed astronaut to tell their colleague, Smith, to put away the marshmallow roaster. This would clean up the aerodynamic profile and stop the oscillation. This is met with resistance that the marshmallow is not cooked yet. This may be expected, as due to the design of the module, it appears as though the marshmallow has been on the outside of the capsule for the entire journey, exposed to the vacuum of space. In this situation, it would have radiated all its heat energy away, reaching temperatures near absolute zero (approximately -273.15 degrees Celsius, the absolute coldest temperature physically achievable). A very brief moment of shock heating from atmospheric effects may not have brought the marshmallow up to a consumable temperature, or even affected the internals of the marshmallow at all. The goal of roasting marshmallows is often to melt the inside of a marshmallow completely, so if this is still frozen, that defeats the entire purpose of the module.

"Houston" is the radio callsign for NASA Mission Control, located in Houston, Texas. During reentry, the

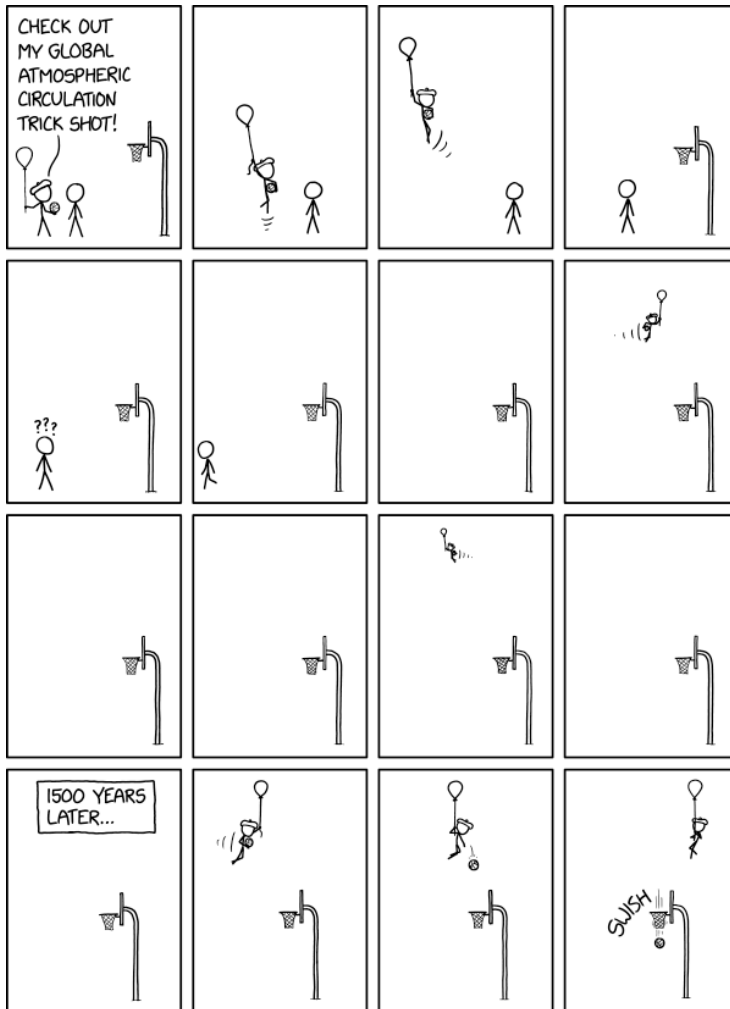
superheated air forms a plasma phase and disrupts radio signals. Hence, it is doubtful that Mission Control would have received this communication from the capsule, and it is very unlikely Mission Control would have received further updates from the capsule until the reentry process was largely finished. This would make the Mission Control operators very concerned over the success of the reentry. But as orbital mechanic and spaceman extraordinaire Scott Manley has discussed the feasibility of roasting a turkey by dropping it from space (and Randall has himself addressed the issue of cooking steaks), the astronauts featured in this cartoon are not straying too far from accepted marshmallow roasting techniques and should not be reprimanded by NASA.

The caption for the panel muses that maybe the concept of the module was a mistake, which is a fair assessment given the number of flaws in the design. It would indeed be far better to have two such units, set upon opposing sides of the module and operated in conjunction, to balance rotational forces. Or even three of them, set 120° apart from each other, perhaps automatically and independently actuated to tune out all other undesired aerodynamic effects – with the added advantage of simultaneously preparing snacks for all three of the astronauts that typically inhabit an Apollo capsule, not just Smith. However, if there is no way to retrieve the marshmallows without exiting the capsule, they would likely be somewhat salty and waterlogged after the time the capsule splashes down and the astronauts can "enjoy" their cooking.

The title text refers to a popular snack of s'mores, made by placing a marshmallow roasted over a fire with some chocolate between two Graham crackers, similar to a sandwich. It also refers to a problem in rocketry, known as Kessler syndrome. Kessler syndrome is a scenario where the density of space junk in low Earth orbit is so high that pieces of space junk crash into each other, breaking apart into smaller pieces. This increases the amount of space junk in orbit, setting off a cascade that could render low earth orbit unusable. These two concepts are combined in a ridiculous way, whereby instead of space junk, it is Graham crackers and chocolate bars that are polluting space. These, combined with the marshmallow from the toasting module, would create celestial s'mores, a novel and frankly wacky concept, as the United States space program does not primarily consist of chocolate and Graham crackers.[citation needed]

#2805: Global Atmospheric Circulation

July 21, 2023



Refs generally say that you can exercise enough altitude control to avoid the ground, but if you start strategically choosing air layers to steer yourself, that's traveling.

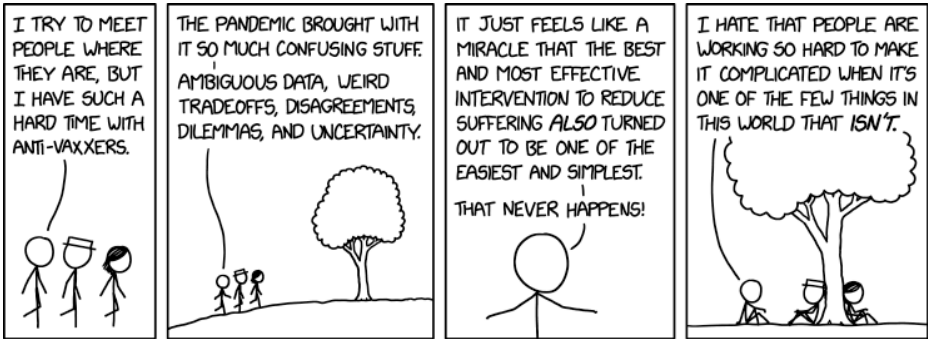
Explanation

In this comic, Beret Guy shows Cueball a trick basketball shot. However, the trick is that he can use atmospheric circulation to roam across the globe, eventually drifting back over the basketball net after the passage of 1500 years. Of course, a normal human being would be long dead after that time[citation needed], and a normal balloon would have lost all of its helium. But, given Beret Guy's special abilities, it is presumed that he could indeed live that long. After waiting for several frames, Cueball is confused at Beret Guy drifting away under a balloon, and thus leaves the basketball court. In addition, Cueball would not be able to witness Beret Guy's shot anyway, as Cueball would be long dead. Beret Guy probably doesn't realize this at all, considering how naïve he is.

The title text refers to the fact that players in this atmospheric circulation basketball game are allowed to maneuver to avoid falling back to the ground, but once players begin to exploit different windspeeds at different altitudes, they are "traveling". This is a joke on the rules of traveling in basketball, where players are allowed to hold the ball without dribbling for two steps before they have to pass or shoot. There's a new rule that allows for readjust that doesn't count as a step, which makes counting the number of steps difficult. It's largely left up to the referee to call. Here too it seems somewhat arbitrary, between adjusting altitude to avoid hitting the ground versus adjusting altitude to steer.

#2806: Anti-Vaxxers

July 24, 2023



The vaccine stuff seems pretty simple. But if you take a closer look at the data, it's still simple, but bigger. And slightly blurry. Might need reading glasses.

Explanation

This is the first comic referencing COVID-19 in over half a year. Anti-vaxxers are people who are opposed to either vaccination in general, or specific vaccine schedules and mandates. The reasons given for this include global-scale conspiracy theories, various forms of pseudo-science, and concerns about vaccine novelty, efficacy and safety (despite the overwhelming consensus of the scientific community being that it's extremely safe and highly effective, and extensively tested). People in this group typically refuse to accept vaccination for themselves and their children, and some actively campaign against the use of vaccines. In this case, it refers implicitly to those who have not taken the COVID-19 vaccine.

The advice to "meet people where they are" is often given when interacting with people you don't agree with. The notion is that you should first seek to understand a person's beliefs, motives and reasoning, and try to respect why they think what they think. Cueball (presumably as a proxy for Randall) expresses support for that advice, but finds it difficult to understand anti-vaxxers. Multiple XKCD strips have made clear that Randall is highly supportive of the COVID-19 vaccines, and frustrated with people who oppose its use.

Cueball argues that dealing with the COVID pandemic was often confusing, leaving people uncertain about what to do. Prior to the availability of the vaccine, the

methods used to control the spread of the disease (including masks, social distancing and lock-downs) were often proposed without clear data as to their effectiveness nor the best way to implement them; conflicting motives also played a role, such as the US government initially being reluctant to propose wearing masks due to concerns that it would lead to a resource shortage. This flip-flopping of information, Randall muses, should perhaps unsurprisingly lead to people becoming suspicious over the consensus rhetoric, never mind that of those who thought that the various mandates were already too tardy, brief, intermittent and/or permeable to properly delay and suppress the initial waves.

In light of all of this, Cueball sees the vaccine as near-miraculous. It's a highly simple intervention, requiring only a series of simple injections that are far less costly and disruptive than most other interventions. Data shows them to be extremely safe with few side effects, and they are more effective in the longer term than any other continuous intervention available. Cueball finds it incomprehensible that, in the middle of so much complexity and confusion, people would reject such a simple and effective solution.

The title text refers to the data concerning the vaccine. He argues that, when you look closely at the data, it continues to look exactly as compelling. For humor, he interprets the idiomatic statement "look closer", which typically means to examine additional details and context, literally. Previous strips have made the point

that the effectiveness of COVID vaccines is so dramatic that even without rigorous statistical analysis, their impact would be obvious. The comment that it is 'slightly blurry' also has a double meaning - it could refer to the inability to focus the eyes properly when staring too closely at it, or it could be referring to the fact that most of the analysis of vaccine effectiveness is statistical in nature, and so has a stochastic, 'blurry' distribution, which 'sceptics' often point to to argue that the evidence is not 'clear cut'.

#2807: Bad Map Projection: ABS(Longitude)

July 26, 2023



Positive vibes/longitudes only

Explanation

This is the sixth comic in the series of Bad Map Projections displaying Bad Map Projection #152: ABS(Longitude). It came about 15 months after the fifth 2613: Bad Map Projection: Madagascator (#248), and was followed 11 months later by 2951: Bad Map Projection: Exterior Kansas (#45).

In this map, Randall has plotted the world map featuring all the landmasses from both western and eastern hemispheres. But the longitudes west of the prime meridian, normally given negative values from 0° to -180° , have been made positive using the "ABS()" function that gives the absolute value by effectively stripping off the minus sign from any value. This results in the features on one side of the world being overlaid upon those of the other side, but mirrored. A similar concept was explored earlier in 1500: Upside-Down Map. The caption "Whoops, made all longitudes positive" is similar to the caption in 2256: Bad Map Projection: South America ("Oops, all South Americas!"). That was a reference to the cereal Oops! All Berries.

Thanks to the relative sparsity of western continents (most prominently the Americas, but also roughly half of Antarctica, the westernmost parts of Europe and Africa, the easternmost part of Siberia, and multiple Pacific islands), and the landless expanses of the Pacific, this is surprisingly not too dissimilar to an east-only fragment

of a world map. Just with the reversed 'new world' lands added to the usual extents of continents of Africa and Eurasia and the somewhat familiar notable Antarctic Peninsula being recognizable but in an odd position (and reversed) with no sign of the Ross and Weddel Seas (as eastern-Antarctic landmass takes precedence). Most continents can be traced out, but North America overlaps so much with Asia that most of its outlines are hidden.

Some features of the real world disappear, such as the English Channel, the North American Great Lakes, and the Strait of Gibraltar. The Arabian Sea becomes a lake as South America cuts it off from the rest of the Indian Ocean (Indian-Pacific Ocean?). To further interest the map-connoisseur, various locations are marked and dotted upon their genuine or reflected positions, putting into close proximity various locations that have (mainly) trans-Atlantic separation in reality. Some of these locations have been renamed in this projection by combining the names of newly overlapping locations. These are:

- The "Palk-Panama Canal", combining the Palk Strait between India and Sri Lanka with the Panama Canal in Central America.
- The "Congo-Amazon Rainforest", combining the world's two largest tropical rainforests, the Congo in Africa and the Amazon in South America.
- The "Hudson Plain", combining Hudson Bay in North America with the West Siberian Plain.

- The "Kara-Baffin Sea", combining the Kara Sea to the north of Russia with Baffin Bay between Canada and Greenland.

Additionally in northern Siberia is the label "Franklin's very lost expedition". Franklin's lost expedition was an attempt to find a passage from the Atlantic to the Pacific through the Arctic passage. Naturally, a sea voyage ending up in the middle of a large landmass would be considered very lost.[citation needed]

The title text references titles found in relaxing music videos called "positive vibes only", attempting to make the listener feel more positive and relaxed. Here, Randall adds his map projection, making it "positive vibes/longitudes only".

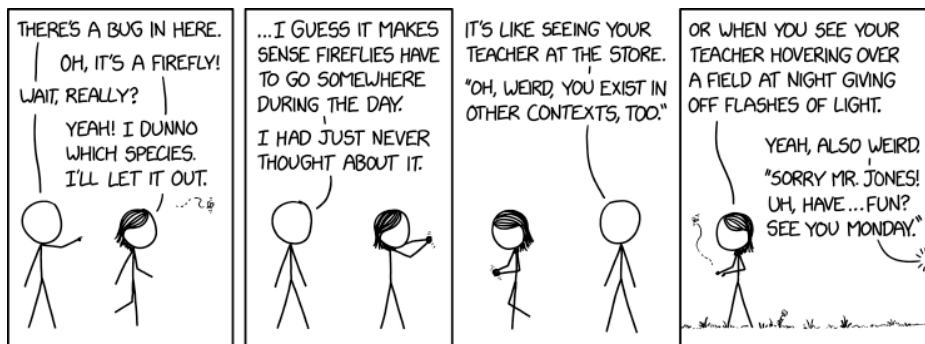
Correct formula[edit]

Possible correct formulae to get only positive longitudes of $0^\circ < \text{LONGITUDE} \leq 360^\circ$, especially from the typical map range of $-180^\circ \leq \text{LONGITUDE} \leq +180^\circ$, are:

These may assist in creating a world map centered on the Pacific, not too dissimilar to the one portrayed in 503: Terminology, which might be the conceit behind this comic's 'error'.

#2808: Daytime Firefly

July 28, 2023



Mr. Jones, watch out for Ms. Lenhart! She's from genus *Photuris*!

Explanation

Some things are associated with being seen so much in a given context that it can be surprising to see them anywhere else. This comic starts with the initially trivial incident of a famously night-time outdoor insect, a firefly, being discovered indoors and during the day.

This quickly becomes another typical observation, that of the experience of a schoolchild seeing someone, whom they normally only encounter in the classroom, 'in the real world'. This may not be strange in small, close-knit communities, but can still be seen as extraordinary, and is sometimes an event that happens after the child (and/or teacher) has left the school, after several years have passed, and is a sign that they are now more equal citizens rather than tutor and student with vastly different non-overlapping lives outside of education.

Unlike fireflies, teachers and other humans generally do not bioluminesce, or flit around in the open air.[citation needed] But that scenario is where the analogy quickly turns, imagining Mr Jones (named as the teacher concerned) behaving like such an insect. Such an encounter would be at least as awkward as bumping into them in a semi-social situation, and the conversation you'd be having could be terribly stilted.

The idea of an outdoor, night-time encounter often involving the deliberate flashing of lights could also bring to mind another activity where car lights can be used to

signal participation, with perhaps a not too dissimilar motive to that of fireflies in the mating flights, in which it might indeed be... 'awkward'... for students and teachers to unexpectedly encounter each other.

The title text continues the conversation with some sage advice, to the firefly-teacher, to avoid Miss Lenhart (presumably, but here with the honorific of Ms.), another teacher of their acquaintance whom they believe to belong to an aggressively mimicking genus of predatory firefly, and thus a potential danger to his existence. The females of those species are known to copy the blinking mating patterns of other firefly species in order to lure the males of those species with the promise of mating but with the true sole intent of eating them. The speaker is clearly concerned that Mr. Jones, while acting out the life of a firefly, will be fooled by Ms. Lenhart's firefly persona and then consumed.

#2809: Moon

July 31, 2023



IF IT DIDN'T EXIST, THE MOON WOULD SOUND
LIKE SUCH AN OUTLANDISH SCI-FI CONCEPT.

I mean, it's pretty, but it doesn't really affect us beyond that. Except that half the nights aren't really dark, and once or twice a day it makes the oceans flood the coasts.

Explanation

The Moon is a celestial body orbiting Earth, first formed approximately 4.5 billion years ago - about 50 million years after the initial formation of the solar system. As of the date of this comic, the Moon is still orbiting the Earth[citation needed] at a distance of approximately 384,400 kilometers, or about 238,900 miles.

This comic points out how weird it is to have such an enormous celestial body near to us. The Moon has a radius more than one quarter of Earth's, and is around one eightieth of Earth's mass, and is so close that major surface features are visible, even with the naked eye, and much more clearly visible with even a simple telescope. Celestial distances tend to be so large that only truly immense objects can be seen without magnification, and even those tend to appear only as points of light to the naked eye. The second nearest body of notable size, Venus, is approximately 46.576 million kilometers away at its closest. The fact that there's "another world" that's close enough that humanity has always been aware of it, but distant enough that it couldn't be reached until a space program was developed, is a striking feature of Earth that we take for granted, only because it's always been that way.

While it's not uncommon for planets to have orbiting moons, no other planet in the solar system has a moon that's so large, in relation to the planet. Of the other rocky planets, only Mars has moons, and the largest of

those is only 14 miles across.

Pluto and Charon are closer in size, than even the Earth/Moon system, but this meant that they had actually become seriously considered as a double(/binary) planet pair, had not Pluto been redesignated as a "dwarf planet". There is the possibility a term such as "double dwarf planet" could be adopted, at some point, as "double minor planet" is sometimes already used for binary asteroid systems. The lesser bodies of the Pluto-Charon system may then even be considered as circumbinary moons.

Other than this, Earth is the only accepted planet we're currently aware of that has a satellite that's so visible from its surface.

The title text sarcastically claims that, other than being "pretty", the Moon doesn't impact us, then subverts it by mentioning substantial impacts it has on Earth. Having such a large satellite so close has impacts that we take for granted only because we're used to them, but if they hadn't always existed, they'd seem unbelievable. One is that, for half the lunar cycle, the moon reflects enough light to produce visibility at night. The other impact is tides, since the gravitational pull of the Moon is large enough to alter the surfaces of oceans, causing shorelines to shift on a daily cycle. The text mentions these dismissively, in a deliberate contrast with their huge significance. Moonlight alters the illumination cycle of the planet to a significant degree, which changes how both humans and other animals operate at night, even

before the advent of artificial lighting. Tides had major impacts on the development of life, continue to affect ecosystems, and play an essential role in our ability to interact with the oceans. If someone from a planet without such a large moon were to observe these impacts, they'd likely be shocked and amazed by them, but we barely notice them.

#2810: How to Coil a Cable

August 02, 2023

HOW TO COIL A CABLE PROPERLY



The ideal mix for maximum competitive cable-coiling energy is one **A/V** tech, one rock climber, one sailor, and one topologist.

Explanation

When long cables or ropes are stored, it's recommended that they be wrapped into neat coils. Not only does this look less messy, but it reduces the danger that cables become entangled with themselves and with other cables nearby. However, simply wrapping the whole thing in the same direction introduces twists into the body of the cable. Over time, these twists can permanently deform and even damage the cable.

In this strip, Cueball demonstrates his method for dealing with such problematic cables: he loudly announces the problem, blaming the cable itself. Well-meaning people then immediately descend upon him, eager to share their obscure knowledge of cable-coiling technique that they claim will avoid these issues (a bit like in 208: Regular Expressions). As they explain their techniques for properly coiling cables, they demonstrate on the cable in question, resulting in it becoming neatly coiled. The implication is that Cueball didn't actually learn the techniques involved, but is confident that, in the future, he can simply employ the same technique to get others to do it for him. It's also implied that loudly (and wrongly) blaming the cable is the most effective way to get help, analogous to Cunningham's Law, which states that "the best way to get the right answer on the Internet is not to ask a question; it's to post the wrong answer". This technique will cause some people to compulsively correct it, particularly those who are serious about the subject in

question.

The title text specifies four groups of people who are likely to have knowledge about coiling cables, and to be serious about the 'right' way to do it.

- A/V (audio visual) technicians constantly work with multiple types of electrical and data cables, and have to store and sort them without tangling or twisting.
- Rock climbers constantly work with ropes, and their lives and safety may depend on keeping those in good condition and using them properly.
- Sailors traditionally worked on sailing ships, which operated using systems of rigging (often quite complex systems) and sailors were expected to be intimately familiar with handling knots and ropes. Even on more modern vessels, mooring ropes (at a minimum) are still likely to be, in turn, deployed and then stored away upon a working vessel at either end of a visit to a port or harbor.
- Topologists are mathematicians who specialize in study of spatial relations in changing shapes, and topology is sometimes referred to (somewhat facetiously) as the science of knots. The joke here is that a topologist could likely give an expert analysis in the theory of coiling and storing ropes, but may lack practical experience for doing so in real life.

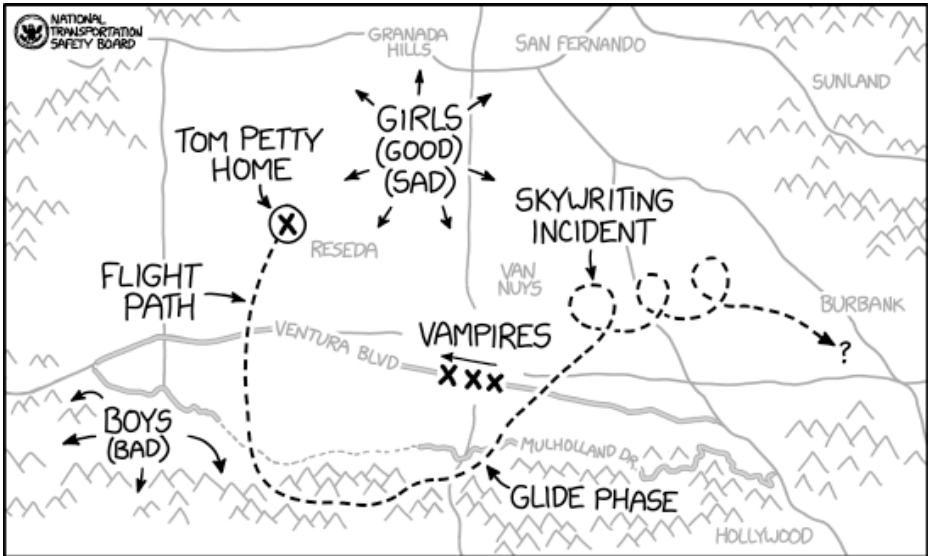
The methods mentioned in step 3 are all references to actual terms and methods involved with storing rope or cable.

- The "Over-under Method" is a way of coiling cable by hand, where every other loop is twisted in the opposite direction to the first. Doing this properly prevents twists, because each coil reverses the twist introduced by the previous coil.
- Figure-8, or "butterfly coil", is a method where a rope or cable is wound from a center point, making a circle in one direction, then another in the opposite direction (forming an '8' shape), then repeating until the whole thing is coiled. This prevents twists by turning the rope in both directions an equal number of times.
- "Quarter-turn" is similar to the over-under method, but rather than reversing the direction of the coils, you give the rope a quarter-twist each time you add a loop, to counter the twist introduced.
- "Flaking" involves laying the rope out loosely on a surface. This allows you to unwind any twists or tangles, as well as checking it for kinks or damage. This would often be a first step in preparing the cable.

The joke is that all of the various people involved will have their own preferred technique, and all will rush to prove their superiority of doing things their way. The net effect of this competition is that Cueball's cable ends up neatly coiled, with little effort on his part, which is exactly what he wanted.

#2811: Free Fallin'

August 04, 2023



DUE TO AN OBSCURE LAW, IF YOU DOWNLOAD A SONG ONTO A FLIGHT DATA RECORDER AND SEND IT TO THE NTSB, THEY HAVE TO DO A REPORT ON IT.

Their crash investigation team had some particularly harsh words for Dave Matthews.

Explanation

The National Transportation Safety Board (NTSB) issues reports on incidents involving various types of vehicles, including airplanes. In this comic, Randall suggests that due to an obscure law, the NTSB has to do a report if a song is downloaded to a flight data recorder. In this instance, the song used is the 1989 ballad "Free Fallin'" by Tom Petty. Interpreting the song's lyrics as a description of an incident, the NTSB's report describes a flight over northern Los Angeles County, California. The pilot apparently takes off from his home in Reseda, gliding over Mulholland Drive, skywriting the name of his loved one, and then presumably either skydiving from the craft or turning off its power to achieve free fall. Assuming Tom Petty is the [amateur] solo pilot, either action would be a dangerous maneuver risking not only his vehicle but the lives of the civilians below, and quite possibly his own.

The title text refers to the 1996 song "Crash Into Me", off the Dave Matthews Band's second album, *Crash*. The investigation team likely would not enjoy a song which reminds them of their job, even if it was referring to love instead of planes.[citation needed] They may also have some particularly harsh words for Dave Matthews if the song *Crash Into Me* was downloaded to a flight data recorder, which would, by the suggested obscure law, create a record of a crash that did not actually occur, making crash investigation difficult.

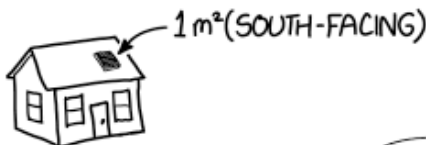
Munroe is a "90s kid," and both of these songs were in heavy rotation on the radio when he was a teenager --- an age when many people make especially emotional connections to the popular music of their era.

Other item labels on the map, unrelated to the lyrics of the song, include Granada Hills, San Fernando, Sunland, Van Nuys, Burbank, and Hollywood.

#2812: Solar Panel Placement

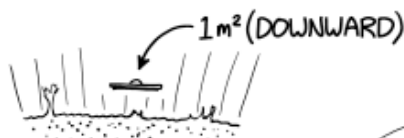
August 07, 2023

OPTION A:



$$(\$0.20/\text{kWh}) \times (4 \text{ kWh}/\text{m}^2/\text{day}) \times (1 \text{ m}^2) \times 20\% = \$58/\text{YEAR}$$

OPTION B:



$$(\$0.20/\text{kWh}) \times \left(\frac{\text{SUN LUMINOSITY}}{\text{SUN AREA}} \right) \times (1 \text{ m}^2) \times 20\% = \$22 \text{ MILLION}/\text{YEAR}$$

SOLAR ENERGY TIP: TO MAXIMIZE SUN EXPOSURE, ALWAYS ORIENT YOUR PANELS DOWNWARD AND INSTALL THEM ON THE SURFACE OF THE SUN.

Getting the utility people to run transmission lines to Earth is expensive, but it will pay for itself in no time.

Explanation

This is another one of Randall's Tips, this time a solar energy tip.

Solar panels generally produce electrical power in proportion to the intensity of sunlight striking them. In order to maximize energy production, it's generally recommended that panels be mounted at an angle that will receive the most light intensity, on average, and avoiding anything that might shade the panels. The comic might be poking fun at how sometimes solar panel arrays are installed in unusual orientations to ensure a south-facing orientation and pushing it to its logical extreme by assuming a panel on the sun.

Based on where the panel is located, the average amount of solar energy expected to strike it per day can be calculated (accounting for the angle of the sun, day and night cycles, and typical weather patterns). With this data, as well as the expected conversion efficiency and local cost of electricity, one can calculate the value of electricity the panel produces each year. In this case, Randall estimates the value of power produced by each square meter of solar cells at \$58 per year.

The strip then proposes a rather intense comparison: place the identical solar panel downwards, on and towards the Sun, rather than upwards (upon a suitable equatorially-facing sloping roof), from the surface of the Earth. Due to the inverse-square law, this would result in

much more solar energy striking the panel. If we assume that the solar cells could convert this energy to electricity at the same efficiency, then this would generate immense amounts of usable power, with the same calculation yielding \$22 million per year as the value of a single panel in such a position.

Of course, such setup would clearly be impossible, for the simple reason that the panels would melt and then vaporize long before they reached the surface of the sun. In point of fact, current photovoltaics operate less effectively at higher temperatures, so even bringing them mildly closer to the sun would impair their efficiency, and eventually cause them to stop working altogether. This is in addition to the fact (acknowledged in the title text), that electricity produced at the sun's surface would be of little use to humans. The solution of "run[ning] transmission lines to earth" would obviously not be practical, even with millions of dollars at stake.

The assertion that the solar panel would pay for itself in no time seems flawed. For example the Helios 1 probe cost 260 million dollars in 1975 (approximately 1.5 billion dollars in 2023 money) and the Parker Solar Probe, which will fly 6.2 million km from the surface of the sun, also cost 1.5 billion dollars. The Parker Solar probe mass is 50kg, which is the same order of magnitude as a 1m^2 solar panel.

There are conceptual proposals, for siting solar arrays in space, but in orbit around earth, rather than on the sun. This would allow for somewhat more solar

intensity, and provide more consistent power, but the obstacles of launching the arrays into space and then transmitting the power remain serious pragmatic difficulties.

The formula Randall uses in this comic is electricity price \times solar irradiance \times panel area \times panel efficiency = savings.

Electricity price is measured in dollars per kilowatt-hour, a unit commonly used by electric utility companies. In both cases, it is assumed to be \$0.20 per kilowatt-hour, which is a reasonable estimate for domestic, retail electric rates in Randall's home of Massachusetts.

Solar irradiance, a special case of irradiance, is the total amount of power delivered to a surface by the Sun per unit area. This measurement varies substantially by geography, and must account for hours of daylight, angle of the sun, and weather patterns (all three of which vary by season). This number is expressed in kilowatt-hours per square meter per day, though this number is typically averaged for the whole year. Randall assumes a value of 4 kWh/m²/day, which is also reasonable for Massachusetts. He also calculates the value for the surface of the Sun as its total luminosity (electromagnetic power, $\approx 3.83 \times 10^{26}$ W) divided by its total area ($\approx 6.07 \times 10^{18}$ m²), which comes out to around 6.31×10^7 W/m² or 1.51×10^6 kWh/m²/day.

Solar panel area is measured in square meters.

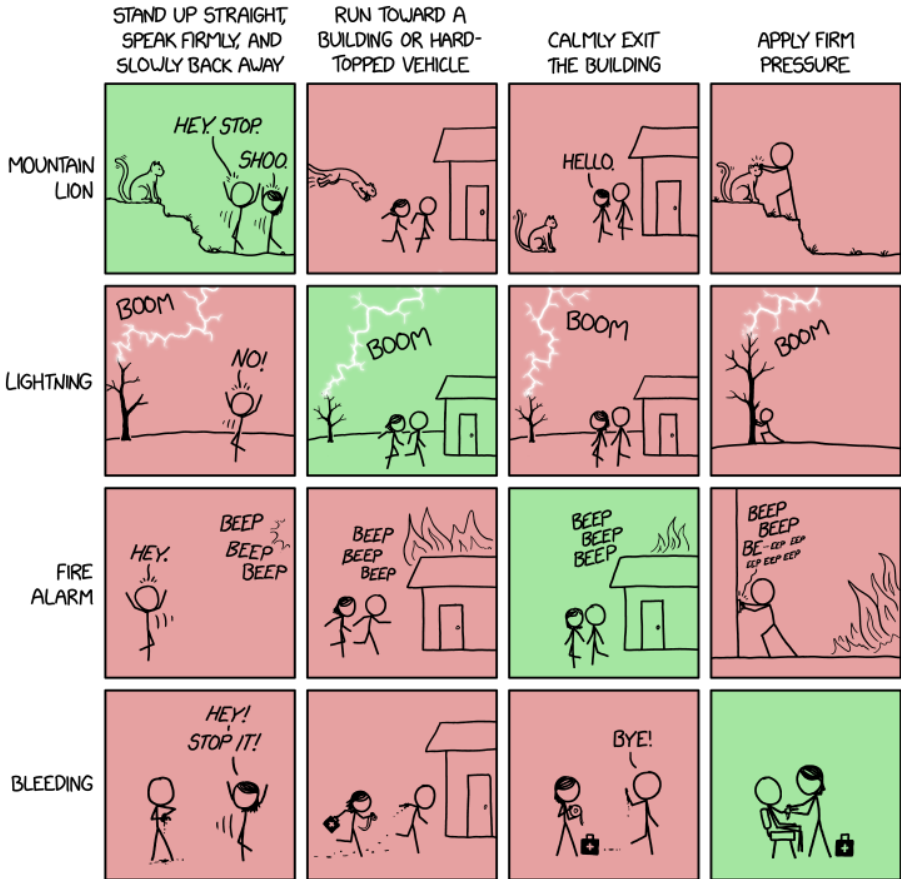
Solar panel efficiency, a dimensionless quantity, is the fraction of solar power that a panel can effectively convert into electricity. Here, both panels are assumed to be 20% efficient, which is a reasonable estimate for commercially available photovoltaic cells operated near room temperature (300K).

Multiplying these quantities together yields a unit of money per unit time, per area (dollars per day per square meter with these specific units). For the parameters for the Earth-bound example, the formula yields \$0.16 per day in effective earnings, which can be multiplied by 365 to get approximately \$58 per year. For the parameters on the Sun, it instead yields \$60,400 per day in earnings, or approximately \$22 million per year.

It should be noted that these values are for each square meter of solar panel. Solar systems almost always consist of multiple panels. With the same assumptions, a 30-square-meter system (which is a relatively small, home system) would be worth \$1,740 per year.

#2813: What to Do

August 09, 2023



FYI: The 'drop, cover, and hold on' advice only applies to earthquakes. If you encounter a mountain lion, you should absolutely not drop to the ground, crawl under it, and hold on to one of its legs.

Explanation

Similar to 1890: What to Bring, this comic takes four unrelated dangerous situations (mountain lion sighting, nearby lightning, fire alarm, and bleeding), and tries to mix-and-match the solutions. Predictably, mixing up good advice leads to fairly nonsensical behavior, so only the original four matches are marked green as acceptable. This comic is also similar, to a lesser extent, to Appliances.

The title-text introduces another disaster, an earthquake, into the mix-and-match. A common safety precaution during an earthquake is to drop, cover, and hold on, which helps prevent you from being thrown about and/or hit by debris. However, attempting to "drop, cover, and hold on" in response to a mountain lion sighting is more likely to get you into danger than out of it.

#2814: Perseids Pronunciation

August 11, 2023

HOW TO PRONOUNCE THE NAME OF THE PERSEIDS METEOR SHOWER	
GENERALLY ACCEPTED	PER-SEE-IDS PURSE-YIDS
ALSO HEARD SOMETIMES	PER-SEE-IDS PER-SAY-IDS
GENERALLY FROWNED ON	PER-SIDES PER-ZAY-UDS PER-SUDS
DEFINITELY WRONG	PERKY-IDS PEWPEWPEWS PER-SAY-SAYS PERCIES PURPS PEPSIDS PEEPS

When speaking out loud, you can call it the 'Perseids meatier shower' and no one will ever know. (If you do get caught somehow, just tell them to Google the 'Kentucky meat shower' and that will distract them while you

escape.)

Explanation

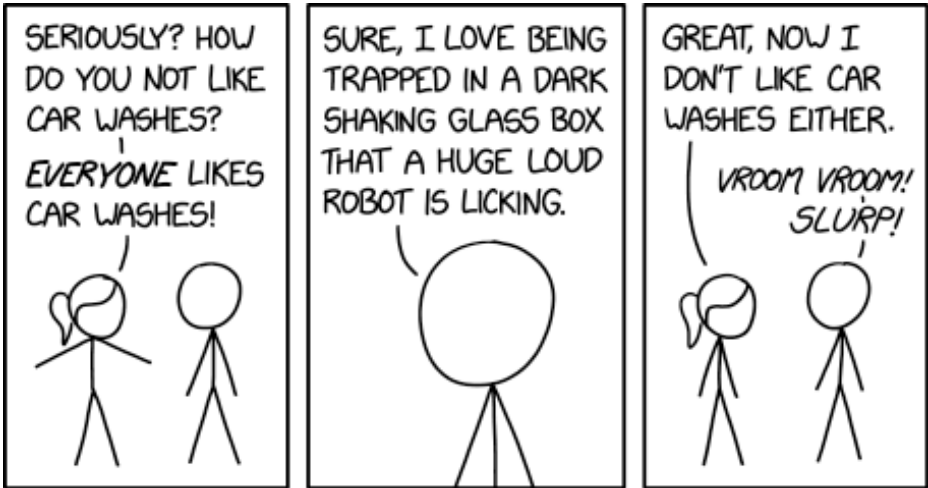
This comic references the Perseids meteor shower, which is active in July and August. Their name ultimately derives from the ancient Greek hero Perseus (for his pronunciation, check Perseus). There are various ways of pronouncing Perseids, and Randall gives the obvious ones before the comic spirals into virtual nonsense, or possibly parodies of common euphemistic replacement words. This is written from an American English perspective.

It should be noted that the last consonant is often pronounced as a "z" sound rather than "s" (the technical term is "voiced"), which is not reflected in these spellings.

The title text mentions how "meteor" sounds like "meatier," although the meanings are completely different. It suggests telling people about the Kentucky meat shower, an anomalous weather event in 1876, as a way to distract them. It also has the word "can" twice.

#2815: Car Wash

August 14, 2023



I'm glad modern car washes use synthetic baleen, instead of harvesting it from whales like **1800s** car washes did.

Explanation

Ponytail and Cueball are having a discussion about car washes. In Randall's area of the world, this usually means an automatic facility that washes cars by passing them through a large machine (or moving the machine over the stationary car) with the passengers still inside. There are also services and events such as fund-raisers where cars are hand-washed.

Ponytail is incredulous that Cueball doesn't like them, because everyone else likes them. He points out that you're trapped in your car (a "dark shaking glass box"). The car wash machine itself is a huge, loud robot, and some of the brushes are like big tongues that lick the car.

After hearing it described this way, Ponytail has come around to Cueball's side. He then mimics the sounds he's described, possibly stimulating discomfort in Ponytail.

The comments attached to this explanation article reveal some of the diversity that exists in people's car wash experiences. Some people enjoy car washes, some don't, some stay in the vehicle, and some leave the vehicle. This could relate to different kinds of car washes present in the world, or it could simply be preference.

The title text implies that modern car washes use "synthetic baleen" for their brushes, contrasting with the entirety of the 1800s where brushes were made of baleen when whale products were commonplace. Today, plastic

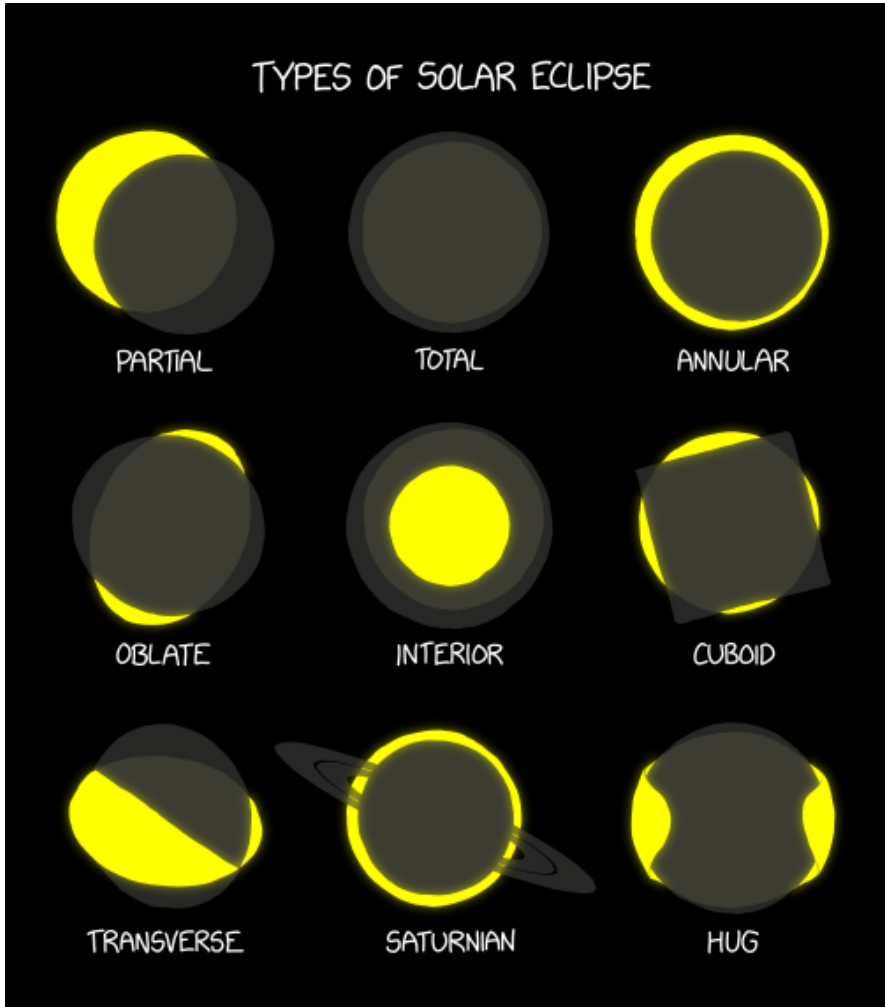
products are commonplace, whales are an endangered species, and use of whale products is considered morally abhorrent. However, motorized vehicle washes as we know them did not exist in the 1800s — the first commercial automobile wash began in 1914.

Baleen, which was processed into a product called whale-bone in the 1800s, was used for large brush bristles as well as fine clothing and many other things, due to its combination of flexibility and stiffness. Evidence of this today is mostly preserved in museum displays. It is possible Randall's comment was inspired by seeing a brush in a museum. The relevant quote from the link is: "In 1808, Samuel Crackles of Hull patented a method of cutting plates of whale-bone to provide an effective substitute for brush bristles. These hard wearing bristles were in much demand, particularly for chimney-sweeps' brushes. Another Hull company, John Bateman and Robert Bowman of Silver Street, were also trading in whale-bone at that time, offering a wide range of small goods including sieves, nets, ornamental blinds, bed-bottoms and brushes."

Despite a debatable visual similarity between baleen and some modern car wash brushes, baleen brushes are not used in modern automated car washes.[citation needed] Among car washes with brushes, chamois fabric or plastic sponge are the brush materials traditionally used.

#2816: Types of Solar Eclipse

August 16, 2023



The best place to be for a hug eclipse is a scenic natural area with good views and few clouds. The worst place to be is the lunar surface.

Explanation

There are various different types of solar eclipse. The comic purports to show and name a number of them, initially quite real and accurate before heading into traditional xkcd fantasticality.

In the title text, the hug eclipse is mentioned again (which is of course, not practically possible as the Sun is about 93 million miles, or 150 million kilometers, away from the Moon (and Earth)), this time in regards to where the best location would be to observe the event. First, normal advice is given about how the best way to view the eclipse (just like actual eclipses) would be in a scenic and natural area, predicted to have few clouds at the time, from somewhere along the rather narrow 'track of totality' for the day.

Then he mentions that the lunar surface would be the worst place to go in a solar hug, because even if it was somehow moved into touching distance by advanced sci-fi tech or a terrible disaster, the Moon would vaporize on contact with the Sun's plasma, thus not allowing for any sort of hug. In fact, we would not live very long if this happened, as the Earth would also be baked by the Sun's light, then swallowed by its intense gravity.

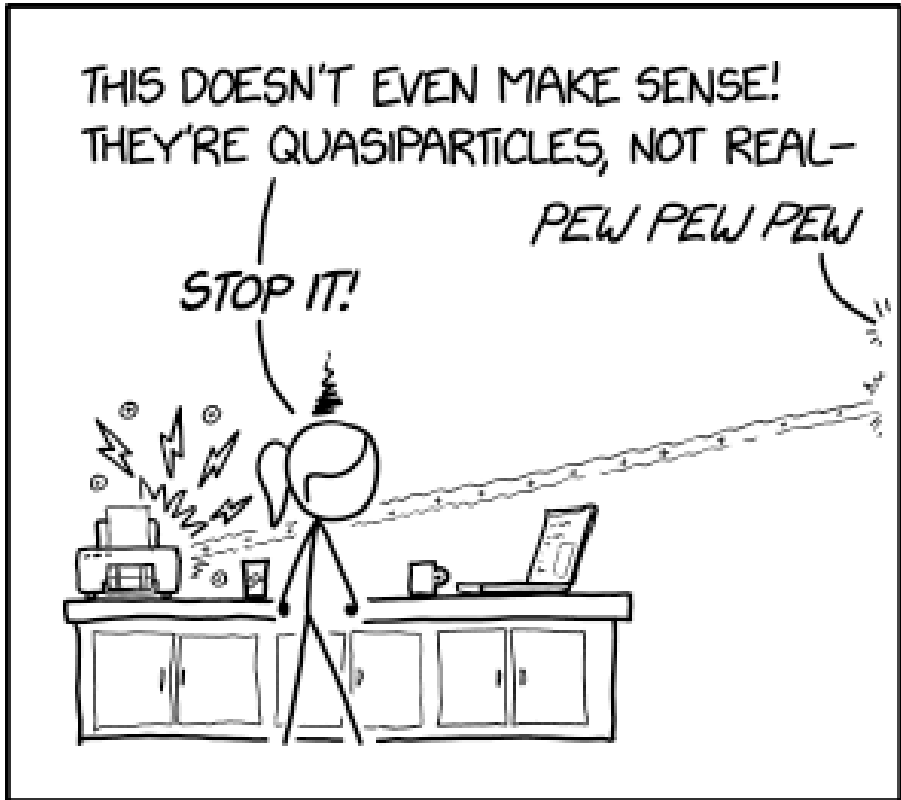
Additionally, a normal Sun-Moon-Earth eclipse seen from the Moon would either be ineffectual or perfectly normal 'night-time', depending upon your lunar location. A Sun-Earth-Moon eclipse, seen from the

Moon would be far more than total (if sought for from the nearside face) due to the much larger size of the Earth blotting out much more of the background, although the 'circular sunset' that gives the fully eclipsed Moon a dull red illumination could be worth seeing.

In all these images, the solar disc does not actually have a solid Moon in front of it, but a semi-transparent shadow, more typical of the representation of the Earth's solar shadow as it passes across the face of the Moon in a lunar eclipse. This may be an additional part of the humor, but it is likely an artistic choice made to improve the diagrams' legibility.

#2817: Electron Holes

August 18, 2023



PHYSICISTS GOT REALLY MAD
ABOUT MY DEVICE THAT FIRES
A BEAM OF ELECTRON HOLES.

They tried to report me to the authorities, but because I had the device they couldn't charge me.

Explanation

Explanation section not found.

#2818: Circuit Symbols

August 21, 2023

CIRCUIT SYMBOLS


 DRAWBRIDGE

 BATTERY

 OVERPASS

 BAERTTY

 POGO STICK


 BATT TTTT-
TTTTTTRY

 EARTHQUAKE

 CHECK OUT THIS
REALLY COOL DIODE

 SHEEP

 WAVE POOL

 TWO SHEEP IN LOVE
TRAPPED ON OPPOSITE
SIDES OF A FENCE

 TROLLEY
PROBLEM

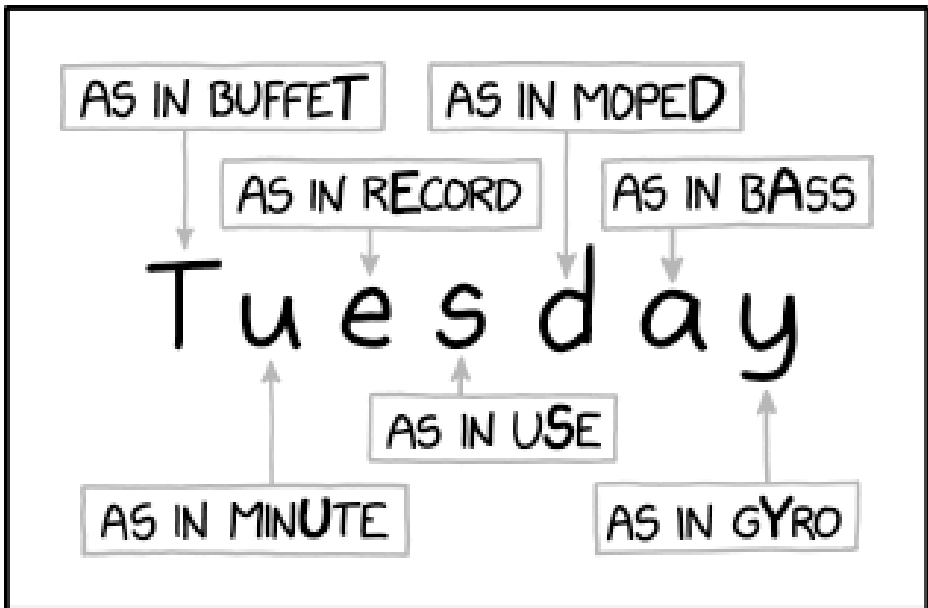
A circle with an A in it means that the circuit has committed a sin and has been marked as punishment.

Explanation

This comic contains several symbols used in circuit diagrams. Each is labeled with a larger object that the symbol looks like a drawing of, rather than the electrical component it actually represents. Randall has previously depicted distorted uses, depictions, and labeling of the standard US-form electronic symbols in comics such as 730: Circuit Diagram.

#2819: Pronunciation

August 23, 2023



PET PEEVE: AMBIGUOUS PRONUNCIATION GUIDES

I pronounce the 'u' in 'pronunciation' like in 'putting' but the 'ou' in 'pronounce' like in 'wound'.

Explanation

Pronunciation guides are used in many languages to indicate the commonly accepted way to translate a written word into sound. This can be particularly important in the English language, where the pronunciation of individual letters and of combinations of letters can vary broadly, and there are very few rules that can be applied consistently. As a result, the 'correct' pronunciation of any given word is determined by common usage, and therefore can only be learned either by exposure or by memorizing them from guides. Some guides use the International Phonetic Alphabet, but the average person is not familiar with those characters, so most guides written for laypeople instead reference familiar words that feature the phonemes.

This, of course, presumes that the reader is familiar with the pronunciation of those words, but the words should be chosen so that a) they're commonly known b) there is only one common pronunciation and c) the pronunciation doesn't vary much between regional accents. The comic seems to be poking fun of this idea by using words which can have vastly different pronunciations even for a single dialect or accent, let alone a geographically spread one, and by extension at how English pronunciation is a mess even at very small scales.

In this strip, though, the selected guide-words are deliberately chosen to be confusing. They are

heteronyms – spellings that are used for multiple words with different meaning which are pronounced in very different ways. Moreover for most of them it is the less common homograph which matches the pronunciation in "Tuesday". In contrast, the pronunciation of "Tuesday" is unambiguous in English — while there are multiple 'correct' pronunciations of 'Tuesday' (with different inflections in different accents) a native English speaker will not have to guess how to pronounce it without context, unlike Randall's guide words. In other words, and to explain the joke, the reader is relying on the pronunciation of "Tuesday" to pronounce the guide words, when the purpose of guide words is to work the other way around.

(Note: General American pronunciations are primarily assumed here except when otherwise stated)

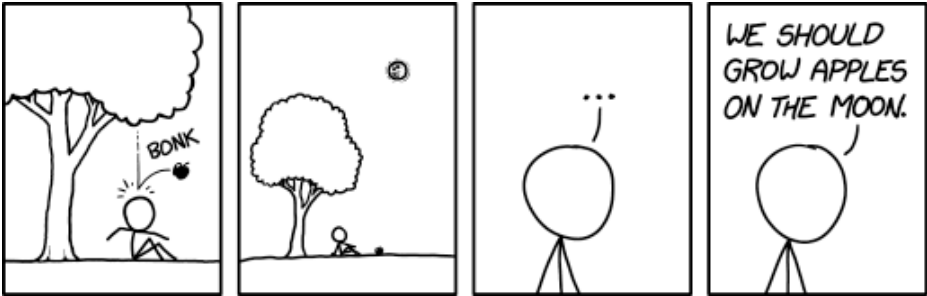
Following this guide, a pronunciation of Tuesday as /iɛstæaɪ/ is possible. You can hear a pronunciation at <http://ipa-reader.com>. A rather famous prior satirical take on spelling/pronunciation oddities is of the word "Ghoti", as a 'valid' spelling of "Fish".

The title text references how some people pronounce the word "pronunciation" like "pronounce" (with /aʊ/) and others use a different vowel (/ʌ/). Here Randall is saying that he pronounces them with the 'u' from "putting" and the 'ou' from "wound". If we take putting to mean /'pʌtɪŋ/ (golf) and wound as /waʊnd/ (coiled), this could mean he pronounces them using the commonly differing pronunciations. However those two words could also be

pronounced /'putɪŋ/ (placing) and /wund/ (injury), indicating a non-standard way of saying each word. In accents that lack the FOOT–STRUT split, such as those in the north of England, both versions of "putting" would be pronounced identically.

#2820: Inspiration

August 25, 2023



An apple fell on Isaac Newton's head and gave him the idea that the moon might be a tasty apple, though this turned out not to be true--the Apollo program eventually determined that it was just a desolate and bland Red Delicious.

Explanation

The apple falling on Cueball's head is a reference to the folk tale about the inspiration for Newton's law of universal gravitation. One of Isaac Newton's biographers reported that his inquiries into the nature of gravity were "occasion'd by the fall of an apple" as he sat under a tree. Over time, this evolved into the story that a falling apple struck Newton on the head. Some versions of the story imagine him gazing at the moon when the apple hits him, and having the revelation that the force pulling the apple toward the earth was the same force that kept the moon in orbit.

In this strip, Cueball (or Isaac Newton) is similarly struck by a falling apple, while gazing at the moon. But rather than an insight about gravity, he makes a different connection, that of starting an apple orchard on the Moon. This would, of course, require some form of massive terraforming project (or at least the construction of a large, pressurized dome), since the airless environment of the moon wouldn't allow any plants to survive. It's not entirely ridiculous that the contrast between the lifeless moon and the lush landscape of an apple orchard would inspire someone to seek to plant life on the moon.

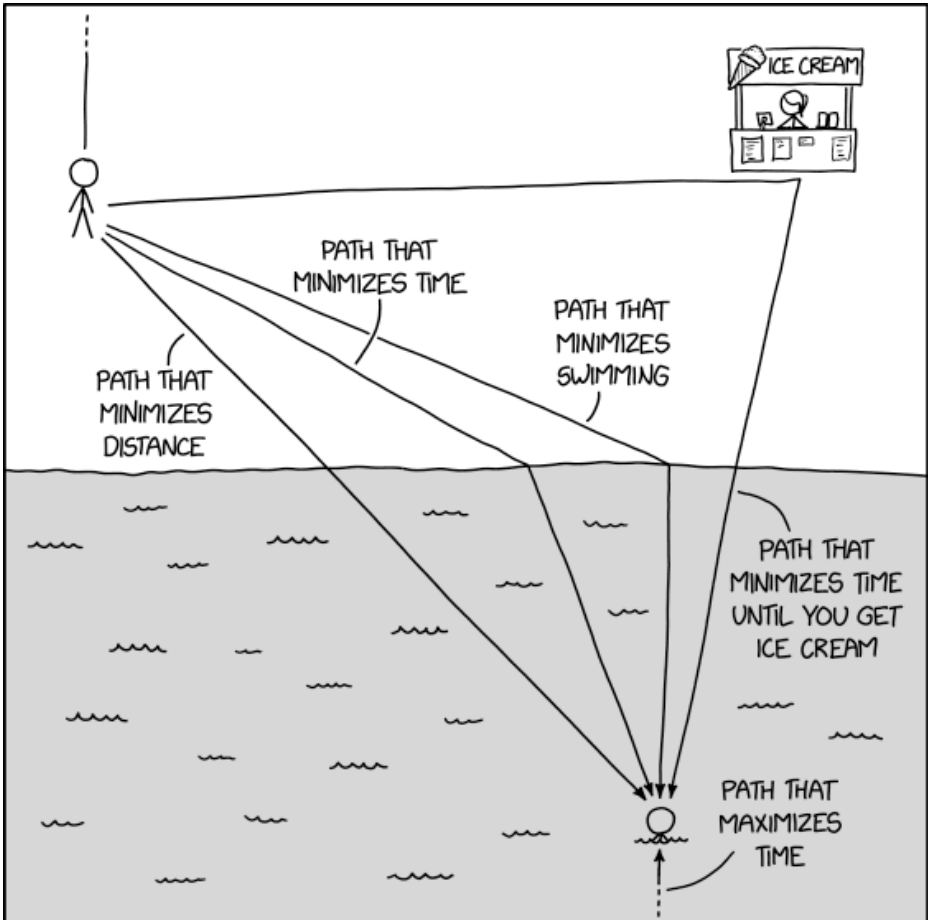
The title text claims that Newton thought that the Moon itself was in fact a tasty apple, but the Apollo program proved it was a Red Delicious apple. This is a jab at Randall's least favorite type of apple, as has been

previously noted. That apple variety became the most popular variety in the USA after its introduction but, to satisfy market demand, growers began selecting for storage and cosmetic appeal over flavor and palatability. Popularity has declined significantly in recent decades. "Desolate and bland" echoes Apollo astronaut Buzz Aldrin describing the moonscape as "magnificent desolation".

The tale of Newton and the apple was previously mentioned in 1584: Moments of Inspiration.

#2821: Path Minimization

August 28, 2023



Of course you get an ice cream cone for the swimmer too!
You're not a monster.

Explanation

In this comic, it appears that Cueball, standing on shore, is observing a swimmer who is possibly (but not obviously) in distress. The comic illustrates five potential paths that can be taken to reach the swimmer, each with a different reason to make them viable, in the manner of demonstrating different optimal strategies that can be chosen.

The first path is a direct line from Cueball, straight to the swimmer, which allows for the minimum possible distance to be traveled, some on land and the remainder in the water.

The second path travels more obliquely from Cueball to the water and then at a sharper angle to the swimmer. This path would take the shortest amount of time, presuming that Cueball would move faster on land (covering more of the distance) and slower through the water (but less distance). The exact angles would depend on how much faster Cueball is on land than in the water.

The relationship between speeds and angles is the same as that in Snell's law for light passing between two media.

The third path travels at a far more oblique angle to the water, such that the subsequent swimming path is entirely perpendicular to the shoreline, adding to the amount of time spent on land in order to minimize the time spent swimming. Depending on one's swimming ability versus running ability, this could be the safest path

to take. It might also be more sensible to keep the target in clear sight for as long as possible, from the land, then aim exactly away from shore when both your head and theirs are barely at wave-height (though currents may complicate this). But this is a completely different reason from the distance or time preferences.

The fourth path travels nearly parallel to the beach, in fact moving slightly away from the swimmer but towards an intermediate goal: an ice cream stand. After that, the path turns and aims straight towards the swimmer, as all the others eventually do (although it is not made clear at this point if Cueball will spend time eating his ice cream on the beach, or will attempt to carry and possibly eat an ice cream whilst swimming).

The fifth and final path, barely recognizable as a path, points off the top of the comic and reappears at the bottom. This path presumably travels around the entire world, likely stopping for many, many rest breaks. It is labeled as the path that maximizes time. It should be noted that, by the definition given, it is theoretically possible to stretch the maximum time taken out forever by simply walking away and never returning.

You could also fulfill the criteria of reaching the target in finite, but arbitrarily long, time by following a random walk(+swim) or even follow a space-filling curve carefully chosen to be the maximally finite scenario. Or you could simply choose any path, and stop for an arbitrarily long time, or travel at a speed approaching zero. In the comic, however, a requirement for simplicity

of path may dictate the use of something close to the opposing great-circle distance, or a variation that has a maximal swim-time even without undue time-wasting detours, and assume equal speeds of travel on all routes.

Alternatively, the fifth path may be a joke playing on relativity. In special and general relativity, timelike geodesics (locally) maximize the proper time between spacetime events. In a spacetime diagram (in sufficiently nice coordinates), an upwards-directed vertical line would be such a geodesic. Under this interpretation, the fifth path isn't a path around the world or through space at all, but through spacetime.

The comic pokes fun at two famous physical/mathematical problems that are usually stated as happening on a beach. The first is the Lifeguard problem, which Richard Feynman, in his book QED, uses to illustrate Fermat's principle, or principle of least time, which states that the path taken by a light ray between two given points is the path that can be traveled in the least time. This is closely related to Stationary-action principle for mechanical systems. In Feynman's words:

"Finding the path of least time for light is like finding the path of least time for a lifeguard running and then swimming to rescue a drowning victim: the path of least distance has too much water in it; the path of least water has too much sand in it; the path of least time is a compromise between the two." - Richard Feynman, QED - The Strange Theory of Light and Matter (1988,

Princeton University Press), Chapter 2.

It is also possible that the comic makes fun of Feynman's idea that a photon (Cueball) would take every path to reach its destination, including the one that goes around the Earth, so that the paths shown are all being taken instead of being options Cueball is considering (therefore he could bring an ice cream to the swimmer).

The second problem referenced in this comic is the Beach Vendor Problem, which is stated as follows. Suppose that on a long beach there are two ice cream vendors. Customers are uniformly distributed on the beach and each person will go get the ice cream at the closest vendor. Each vendor wants to maximize the number of customers that buy at their place. To minimize the customer's walking time, the optimal configuration would be to have one vendor at $1/4$ of the beach length and the other at $3/4$, but Hotelling's law predicts that the two shops will converge to the middle of the beach, in an attempt to steal as many customers as possible from the competition. This is a case of Nash equilibrium that is also related to the Median voter theorem. If the number of vendors is larger than 2, the problem may become considerably more complicated.

The title text adds to the ice-cream path the stipulation that you also carry an ice-cream to the target swimmer to 'justify' that choice of route. But how this squares with the reason to rendezvous with the swimmer, or the manner in which this would further complicate the swimming stage, goes unsaid. But it makes it clear that

not doing this isn't considered socially permissible, whether or not he had stopped to eat an ice-cream of his own beforehand.

#2822: *@gmail.com

August 30, 2023

TO: *@GMAIL.COM

CC:

BCC:

SUBJ: NEW FRIENDS

HEY ALL! GO AHEAD AND
INTRODUCE YOURSELF!

IF GOOGLE EVER DECIDES TO SHUT DOWN
GMAIL, THEY SHOULD LET ONE USER
TRIGGER A GLOBAL REPLY-ALL APOCALYPSE.

Hi all, just replying to loop in *@outlook.com and
*@yahoo.com.

Explanation

When performing operations on computer files using a command prompt, the asterisk (*) may be used to represent a collection of items whose names match a particular format. For example, `*.txt` denotes all files whose names end in `.txt`. This is called a wildcard character. Similarly, the e-mail address `*@gmail.com`, as illustrated in the comic, is a proposed feature from Randall that would send an email to every Gmail user, without having each and every valid Gmail address at hand (of which there are about 1.8 billion). For obvious reasons, this is not actually a feature, but Randall suggests that if Google ever wanted to shut Gmail down, they could either do it this way (possibly causing a service-ending overload of resources) or allow someone this one last boon (as a farewell gift, knowing that there would be relatively few additional repercussions to deal with). Google does not seem particularly likely to shut down Gmail, as it is a source of information for their advertising and other businesses, but they are known for abandoning programs and projects even after they have been found useful (by at least some people) for years.

Reply-all is a sometimes useful feature of email that nonetheless commonly causes headaches and annoyances for both users and administrators. By allowing users to simply reply to everyone copied on the email, it encourages users to do this rather than think carefully about which people their response should be addressed to. This causes lots of users to receive irrelevant emails,

and email servers to have to process and store a lot of unnecessary data. Randall's email is essentially designed to induce every Gmail user to email every other Gmail user, generating an excessively large number of emails.

A recurring phenomenon for email users, especially in the early Internet days of the 1990s and 2000s, was a reply all storm – someone would start a message to a very large group, perhaps hundreds, and even if only 5% of recipients replied to say something like “take me off this list“, a storm of dozens of replies would soon follow. Inevitably, new replies to everyone would start saying things like, “stop Replying All!” If this were done with millions of Gmail users instead of just dozens or hundreds, their result would be apocalyptic. A similar real-life example was a 2016 incident involving 1.2 million staff at the UK National Health Service.

In reality, the asterisk wildcard is not generally usable via email servers, although email clients may sometimes implement such a function, internally, perhaps to support mailing-list functions (though more commonly this is done via named address-book 'groups'). That said, the asterisk character is a valid one that may form part of the name of a mailbox, including group-boxes that might facilitate server-side distribution.

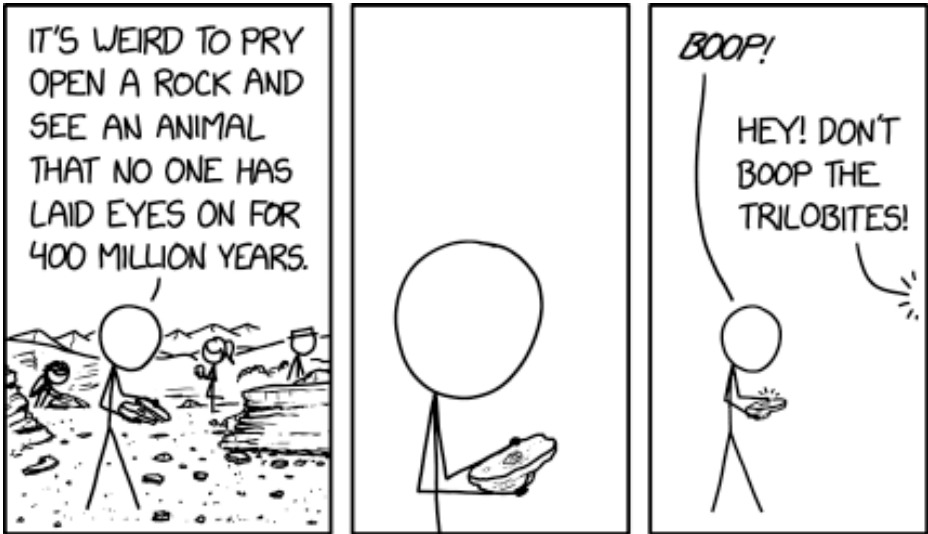
Now, organizations operating their own e-mail domains frequently implement mailing lists such as or , and these lists occasionally cause reply-all storms, which usually results in the organization restricting access to the list to trusted

administrators. Here, Randall proposes doing the opposite and opening the list of all Gmail users to everybody.

The title text suggests a reply where someone decides that all users of Outlook.com (formerly Hotmail) and Yahoo! Mail, two further well-known mail services with similarly large user bases, should also be included - "loop in" is common business jargon for meaning "include in communication about something", related to "being in the loop" meaning "being informed and up to date". Accepting this would trigger an even bigger reply-all "apocalypse", as the chain will get even bigger and will include accounts for services not presumably about to be shut down like Gmail is in the comic, thus bringing down all significant platforms for e-mail services. This also alludes to an occurrence in email chains where a user replies to simply add another user into the chain, which doesn't add much information to the group.

#2823: Fossil

September 01, 2023



The two best reasons to get into fossils are booping trilobites and getting to say the word "fossiliferous" a lot.

Explanation

Trilobites are an extinct group of species of marine animal, one of the earliest known groups of arthropods. The first appearance of trilobites in the fossil record is from about 521 million years ago and last from about 252 million years ago. They were very common and have easily fossilized exoskeleton, so their fossils can be found very often.

In the comic, Cueball is digging at a site with Megan, Ponytail, and White Hat visible in the background. He finds and digs up a trilobite fossil and proceeds to boop it (possibly because he thinks it's cute?). "Booping" is when someone lightly taps another person, or sometimes an animal, on the nose while saying "boop", typically to annoy or as a form of endearment. In panel 2, the fossil is shown with the trilobite head pointed away from Cueball. In panel 3 he boops the head section, likely aiming for where the nose would be, if one were to imagine a trilobite having a nose. The anatomical part of the trilobite being "booped" is referred to as the glabella by palaeontologists. The Glabella is located in the center of the cephalon (head), where one would expect a nose to be located.

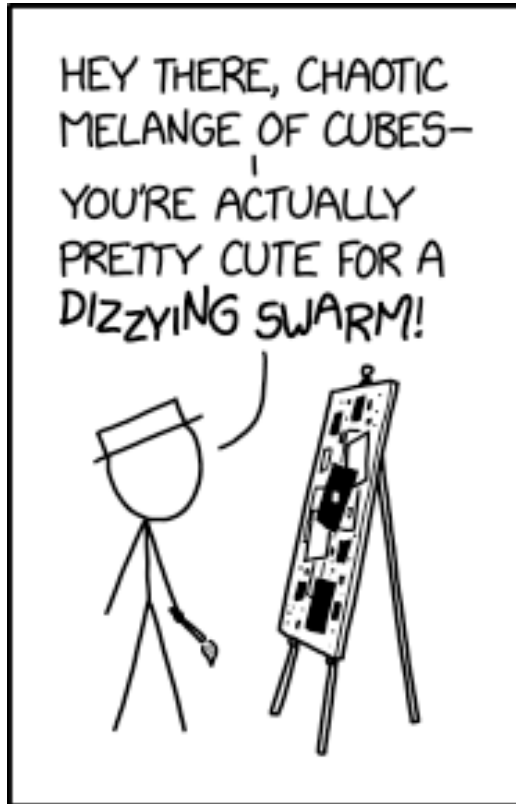
An off-screen character yells at him for doing this, probably because fossils are often fragile and excessive touching may cause it to break, or because doing so is not showing the due respect for a once-living being that is much older than Cueball, or because Cueball might

contaminate the sample, or because overly strict rules are funny.

Fossiliferous (of a rock or stratum) means containing fossils or organic remains, and Randall implies that it is a fun word to say (it really is!).

#2824: Abstract Pickup

September 04, 2023



BAD NEWS-THE PICKUP
ARTISTS AND ABSTRACT
ARTISTS HAVE MERGED.

Escape Artist Frees Self From Conversation With Pickup Artist

Explanation

Abstract artists are individuals who create artworks that do not attempt to represent external reality. Instead, they emphasize shapes, colors, forms and gestural or non-representational elements in order to convey emotions, concepts or ideas. Abstract art can take various forms, including paintings, sculptures, and other visual media.

Pickup artists are individuals who engage in strategies and techniques to attract and form romantic or sexual relationships with others, typically focusing on short-term or casual encounters. These strategies often involve tactics for initiating conversations, building rapport and escalating physical intimacy. Pickup artistry is often associated with misogyny, manipulative behavior and a lack of respect for others.

Stereotypical pickup artists are misogynistic males who feel disproportionately hard done by and are (over)reacting to the perceived antipathy from "all women" and a typical technique that they might use is "negging", or making a comment which is intended to lower their target's self-esteem under the guise of being perfectly normal (and even complimentary) small-talk. Randall has previously indicated his disdain for pickup artists in 1027: Pickup Artist and 1178: Pickup Artists.

The word "artist" has different meanings in these two phrases. In the first one, it means someone who makes

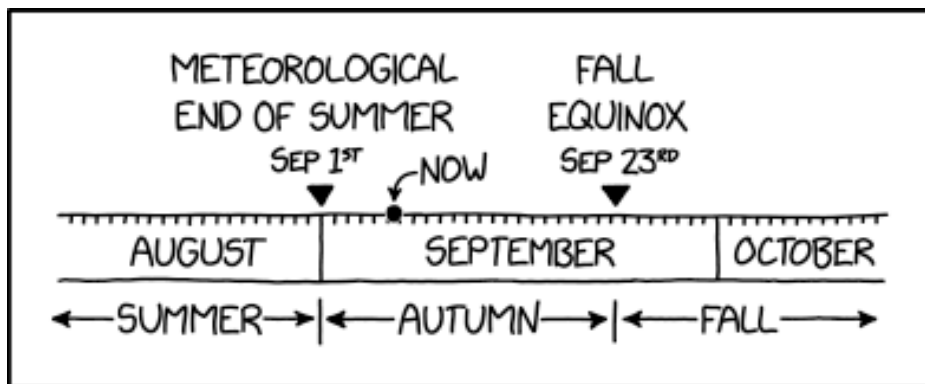
paintings as a profession or hobby, and "abstract" narrows down the types of paintings. In the second, it means a practitioner of some activity, and "pickup" is the (reprehensible[citation needed]) specific activity. The joke is in conflating the two senses when saying that the two groups have merged.

White Hat is a representative of this combined group and in his usual fashion seems to have mixed the two in a peculiar manner, calling a bunch of cubes "cute". He's talking to a group of cubes he has just painted, which he describes as a melange (being an artistic term for a disordered mixture), in his role as an abstract artist. But by the end of his comment he has passed through a disarming compliment (that they are "actually pretty cute", seemingly saying that few other people will ever think the same), revealing his pickup artist tendencies by seemingly dismissing them as a "dizzying swarm" which few would call "cute" (showing White Hat's signature peculiarity as no one will call a melange of cubes cute).[citation needed]

In the title text, it appears that a third type of artist (the escape artist, again very different from both of the other types of artist) has fulfilled their own "role" by escaping from conversation with a pickup artist. Assuming that the escape artist is a woman, this might be an additional joke that pickup artists are not good at "picking up" women and instead just act like "a bunch of chains" to escape from.

#2825: Autumn and Fall

September 06, 2023



NOW THAT SUMMER IS OVER, THE FIRST DAY
OF FALL IS JUST A FEW WEEKS AWAY!

Of course in reality this is just a US/UK thing; in British English, 'fall' is the brief period in between and 'autumn' is the main season.

Explanation

Autumn, also known as "fall" in the United States (short for 'fall of the leaf'), is the season between the end of summer and the beginning of winter. These terms are used interchangeably, but Randall in this comic treats them as separate seasons. His timeline uses "autumn" as the season between the end of summer and the "fall equinox", and the season of "fall" as the period after that until winter. While many different parts of the world use different ways of reckoning the seasons (eg, a two-season system in the tropics or a six-season system in South Asia), nowhere uses the type of five-season system shown in the comic, nor the extrapolated eight-season system it may even imply.

The comic depicts two of the commonly used boundaries, for any given hemisphere, for the recognized end of summer. While other cultures have adopted yet other dates, according to their own calendars or local experience, Randall may have encountered several other 'standard' methods of dividing the year.

- Some treatments of the seasons (not shown) treat the summer solstice very much as "midsummer", and all other seasons also more or less equally straddling their own equinoxes/remaining solstice, putting the seasonal boundaries half way between each of these astronomically significant points.
- For others, the equinoctial/solstitial dates are used for

the changeover time, so that autumn/fall starts upon the equinox (shown) and ends at the astronomically shortest day which is then the start of winter. This system tends to be traditional where the annual warming and cooling of the climate significantly 'lags' the solar calendar.

- Meteorological seasons are handily aligned to months, for administrative reasons. Spring (short for 'spring of the leaf') is March through May, summer across June to August, the September start (to the close of November) is as illustrated, leaving winter to be covered by December and on until the end of the following February. Or shifted round by two of the triples for the southern hemisphere.
- For practical purposes, many in the U.S. treat Labor Day as the unofficial end of summer: this is the day many local pools close for the winter, people start watching football rather than baseball, have their last picnic of the year, etc.

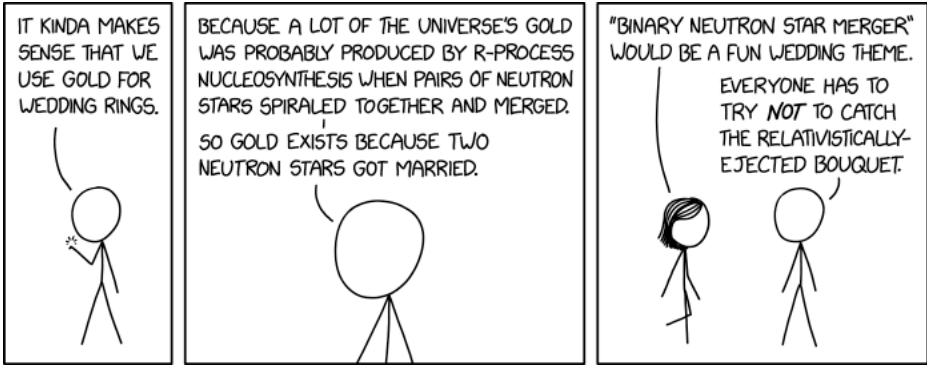
The joke here is that, because Americans do not use the term "autumn" very often in normal communication, someone might be led to believe that it had a special unusual scientific meaning.

The title text makes fun of the transatlantic difference in terms, as it claims one must reverse these two distinct season names. The term "autumn" is, in reality, the word overwhelmingly used in the UK for the season commonly (but not exclusively) referred to as "the fall" in the US, regardless of which of the calendar offsets is to be

assumed, and the equinox is, accordingly, called the autumn equinox. "Fall" is rarely used 'natively' in the UK (although it will usually be understood), with the main exception being that it handily allows for the mnemonic of "spring forward, fall back", which uses wordplay to refer to how and roughly when British Summer Time (UTC+1) takes over from the default Greenwich Mean Time (UTC±0).

#2826: Gold

September 08, 2023



It can be expensive to hire a professional spectroscopist for your wedding, but the quality of the spectra you get is worth it.

Explanation

Much human jewelry is made of gold for several reasons. It's rare enough to represent a symbol of prestige, but common enough that the working class can reasonably afford to buy it for a special occasion. It's hard enough to survive handling by people, but soft enough that jewelers can easily repair or resize it. And it's virtually immune to weathering and corrosion so it won't degrade during the wearer's life. Most wedding rings contain gold.

In this comic, Cueball points out another reason to make wedding rings out of gold, one he finds more poetic — though the symbolism in this poetry, in true Randall fashion, is couched in astronomy and science. As the comic states, gold is most commonly created by r-process nucleosynthesis in the mergers of neutron stars (the process entailing the rapid capture of free neutrons before either the atom or free neutron decays, therefore requiring a high density of neutrons); something which could be seen as analogous to a marriage. About 94% of the gold on Earth was created this way, with the rest made by supernova nucleosynthesis.

Wedding receptions sometimes have a theme, which is used to style the decorations and activities of the party. If the couple has a shared interest in something in popular culture (especially if this is how they met), they might use that as the theme. Megan suggests that "Binary Neutron Star Merger" would be a fun theme; this would probably only be true for astronomers or cosmologists.[citation

needed]

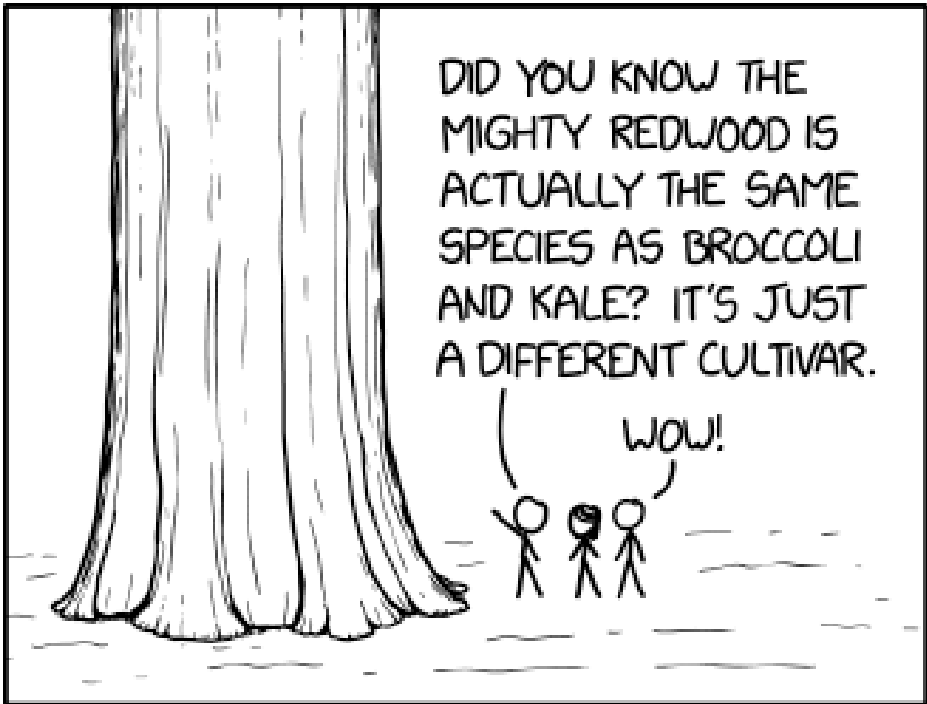
Cueball adds that an activity at such a wedding would be ejecting the bouquet at relativistic speeds; this is a reference to the traditional activity of the bride throwing her bouquet into the crowd, with whoever catches it predicted to be the next to get married. The collision of neutron stars ejects material with enormous amounts of energy and therefore at high speeds. So, for a "Binary Neutron Star Merger" theme wedding, the ejected bouquet would therefore be traveling "relativistically" (i.e. at a high fraction of the speed of light). If you caught such a bouquet while at rest relative to the merger point, you would be destroyed by the energy, so everyone tries not to catch it in that fashion. Of course, as shown in the what if? link above, everyone in the room and the surroundings would be vaporized if such a feat was possible. This would make the theme appropriate in addition to being "fun" as the wedding would be just as bright and energetic as a binary neutron star merger.

Continuing with the cosmological theme, the title text suggests that the wedding photographer would be a spectroscopist. Spectroscopy, which determines the composition of materials, including those far away such as exoplanets, stars, binary neutron star mergers and other astronomical phenomena, by measuring and analyzing the wavelengths emitted, to see which wavelengths are strong and which are missing/have a weak intensity, and comparing these to the characteristic spectra of different elements. After the relativistically-ejected bouquet is thrown, he would be

able to make a nice spectroscopical image/photo of the entire wedding ceremony if he stood far enough away. (He would, of course, not be able to present it to the bride, as she was part of the system which was destroyed in the process of the light and energy being emitted.)

#2827: Brassica

September 11, 2023



EVERY YEAR OR TWO, BOTANISTS ADD
ANOTHER PLANT TO *BRASSICA OLERACEA*
AND SEE IF ANYONE CALLS THEM ON IT.

Sequoia Brussels sprouts are delicious but it's pretty hard to finish one.

Explanation

Brassica oleracea is a plant species, that contains 23 different cultivars (plants which evolved primarily due to human selection) of wild cabbage, a relatively nondescript herb, to which many vegetables that we eat belong. These vegetables look quite different from each other, though all share the same basic appearance; compare, for example, cabbage, broccoli, kale and brussels sprouts.

In the comic, Cueball, who is serving as a natural-history tour guide or park ranger, or maybe is just leading a group of friends, declares that the "mighty redwood" (presumably the coast redwood, *Sequoia sempervirens*) also belongs to this species. Since the coast redwood is a conifer, while *B. oleracea* is a flowering plant, the two species are about as different as two land plants can be, both in classification and appearance.

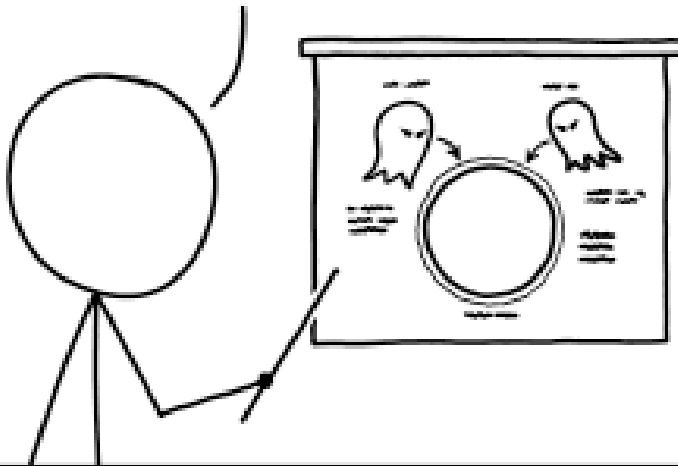
However, when viewed from high above, the canopy of forests can bear a striking resemblance to the top of a head of many of these cultivars. In this case, the pointier tops of conifers would more likely resemble a *romanesco*, while broad-leaved forests would be closer to the more commonly encountered *calabrese*. Such far-fetched resemblances could be used by a botanist as a joke to see if anyone is paying enough attention to call them out, which according to the caption, seems like something botanists do every year or two.

The title text refers to Sequoia Brussels sprouts. The reference is probably to the Giant Sequoia (*Sequoiadendron giganteum*), a close relative of the coast redwood. "Resinous" is probably a more apt adjective than "delicious", and they're probably woody. Additionally, as stated, they would indeed be quite hard to finish - Sequoia trees can range from 50-85 meters in height, and so consuming them will take weeks or maybe months, a monotonous task despite their "deliciousness". It is probably no more advisable[citation needed] to stand under a sequoia bearing sprouts than it is to stand under a cannonball tree.

#2828: Exoplanet Observation

September 13, 2023

WHEN THE PLANET PASSED IN FRONT
OF ITS HOST STAR, SOME OF THE LIGHT
WAS ABSORBED BY GHOSTS, INDICATING
THAT THE PLANET IS LIKELY HAUNTED.



EXOPLANET SPECTRAL ANALYSIS

NASA prefers to say that their rovers are 'looking for signs of past life on Mars' and not 'ghost hunting.'

Explanation

In this comic, Cueball states that observations of light that passed through the atmosphere of a distant planet indicate that there are ghosts on that planet, because some of the light was absorbed in a way that is unique to ghosts. This is analogous to how gases or suspended particles absorb certain wavelengths, allowing scientists to identify properties of distant objects using telescopes. The pun is that in this comic "spectral analysis" refers to both the analysis of the light spectrum and the analysis of specters (ghosts).

Spectral analysis is the study of the electromagnetic spectrum that results from the interaction between electromagnetic radiation (including visible light) and matter. In the study of exoplanets and other distant objects in space, it refers to using the intensities of different frequencies of light (and other electromagnetic radiation) from stars which they occlude to infer data about their chemical composition. This is used to detect certain gases in the atmosphere, such as free oxygen, which might suggest generation by and for Earth-like life. On the day before this comic was published, NASA announced that spectral analysis of the exoplanet K2-18b showed abundance of methane and carbon dioxide, and shortage of ammonia, which are chemical footprints that support the hypothesis that it may have a life-supporting water ocean; and there was possible detection of dimethyl sulfide, which on Earth is only produced by life. If confirmed, these would be very interesting

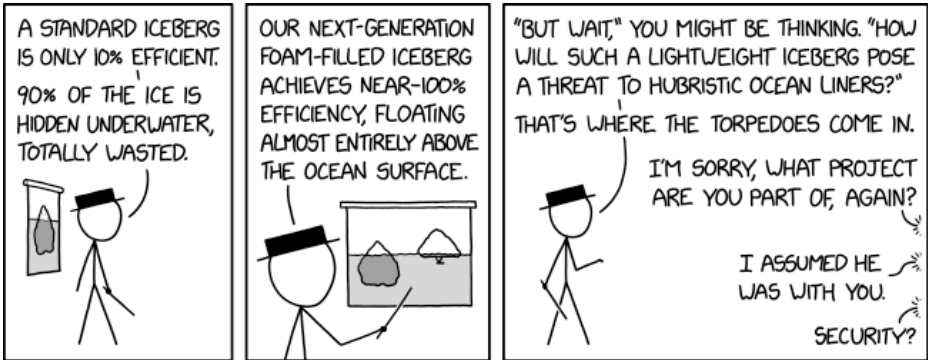
findings, although it may turn out to be less remarkable on closer study (as with Venus for example).

"Spectral" also has another meaning: relating to specters (ghosts). Hence "exoplanet spectral analysis" could be interpreted as the analysis of ghosts on planets outside the solar system instead of the analysis of the elements that might be present on the planet. "Specter" and "spectrum" have the same etymological root, deriving from Latin "spectrum" meaning "appearance", with a specter specifically referring to a visible shadow or ghost.

The title text refers to the search for past life on Mars. Just like the comic, it also humorously conflates the practice of searching for signs of past life such as specific molecules or fossils (which NASA does actively search for), versus the disreputable practice of searching for ghosts, with this conflation framing both as an equally scientific indication of past life. In a very loose sense, real signs such as gases or fossils could be considered "ghosts" of past life.

#2829: Iceberg Efficiency

September 15, 2023



Our experimental aerogel iceberg with helium pockets manages true **100%** efficiency, barely touching the water, and it can even lift off of the surface and fly to more efficiently pursue fleeing hubristic liners.

Explanation

This comic humorously plays with the idea of efficiency in a typically absurd and satirical "Black Hat" fashion. Black Hat starts by critiquing traditional icebergs, which are mostly hidden underwater, as inefficient. Efficiency is typically measured in relation to a desired outcome or purpose; Black Hat seems to imply that the obvious purpose for icebergs is to be seen above the water. He then presents his solution - a foam-filled iceberg that floats almost entirely above the water, claiming it to be highly efficient.

Black Hat's idea is characteristically absurd. Icebergs are naturally formed structures, with no particular purpose in existing. It is possible to imagine edge cases where a "more efficient" iceberg would be desirable, such as if the goal were to increase the overall albedo of the planet (perhaps to mitigate climate change), but on the whole his proposal to create a "foam-filled iceberg" is not only impractical but also comically exaggerated.

Black Hat then absurdly suggests that his lightweight iceberg can still pose a threat to ocean liners (as if that's the "purpose" of icebergs – in the 20th century, at least six ships sank as a result of iceberg collisions, most famously the RMS Titanic) through the use of torpedoes. In addition, given that Black Hat is promoting the idea that icebergs should be able to damage ships, it's not really so inefficient to have much of the iceberg underwater, since ocean liners also have a

significant portion of their hulls underwater, where they can be damaged by icebergs. The second panel shows that the foam-filled iceberg has a small attachment underneath it, perhaps a turret for launching torpedoes.

The unnamed individuals in the last panel are clearly baffled and concerned at how Black Hat got to presenting this slideshow, especially after Black Hat brings in the idea of torpedoes, presumably alerting them to the idea that the presentation is not just some incomprehensible novel idea for mitigating climate change or some other advantageous purpose. Realizing that Black Hat is not authorized to be there, presumably having snuck in with someone dealing with iceberg-related ideas, one of them calls for security. This is just another typical example of Black Hat presenting absurd ideas in a calm fashion.

The title text introduces the concept of an "experimental aerogel iceberg with helium pockets." Aerogels are a class of solid, porous materials known for their extremely low density (making them among the lightest solid materials yet synthesized). Their low density should make them float well in liquids, though their low mass and their porous and brittle material properties make them unsuitable as a ramming implement. They are very strong for their mass, but would not be able to support iceberg-sized amounts without collapsing without internal supports which would vastly outweigh the aerogel. Most aerogels cannot float in water without some kind of surrounding coating or container, since the water would soak into the aerogel as it does a sponge.

Worse, most aerogels are very hygroscopic, and contact with liquid water can destroy them because attraction to the water collapses the structure. (This can be prevented by treating the aerogel with a hydrophobic material that coats the aerogel particles.) The structure of an aerogel surrounds pockets of air, leaving spaces that could be infused with a specific gas such as helium. Helium is lighter than air, and is often used to make gas-filled objects such as balloons float. An aerogel iceberg infused with helium gas could theoretically hover or fly like a balloon as suggested in the comic. This idea of producing a man-made flying iceberg for the sole purpose of endangering cruise liners is preposterous, as there's no reason to do this - and even if there were, more practical or direct methods of attacking such vessels exist.[citation needed]

The mention of this high-tech iceberg being able to "more efficiently pursue fleeing hubristic liners" is a playful nod to the comic's theme of optimizing icebergs for efficiency at attacking ocean liners. It implies that not only can this special iceberg float efficiently, but also that it's equipped to chase after and "efficiently pursue" arrogant or prideful ocean liners, turning the concept of iceberg efficiency into a surreal scenario. The "hubris" alludes to the (possibly apocryphal) quote "God himself couldn't sink this ship" and similar sentiments expressed in reference to the Titanic.

#2830: Haunted House

September 18, 2023



THE HAUNTED HOUSE AT THE ISO/ANSI OFFICE HALLOWEEN PARTY

You can leave at any time through the door over there. It's a Louisville door, so you'll need to find a compatible knob. No, don't be silly, that one is a Lexington knob! Of course it won't fit.

Explanation

The ISO (International Organization for Standardization) and ANSI (American National Standards Institute) are organizations that create standards for commonly used objects such as electrical sockets, preferably so that there would exist standardized forms everywhere (or at least across large areas). The comic depicts an office Halloween party, which is a common event on the celebration of Halloween. A "haunted house" is a house or other building/room designed to induce fright in the participants, typically by including well-known/cultural scary elements such as vampires or zombies. The haunted house in this comic is tailored to scare members of these organizations by suggesting a world where nothing is standardized (e.g. different electrical wiring from state to state). The title text furthers the joke by implying that something which is usually standardized (door/doorknob interfaces) would be different from city to city even within a state. Further, it confounds types of "knobs", where "Lexington" is a hardware style collection for actual drawer knobs and such, whereas the "Louisville Knobs" are a set of geological mound features (Knobs region) in Kentucky. While such a joke would likely only irritate ISO members, the comic jokes that they fear even the idea of such a world.

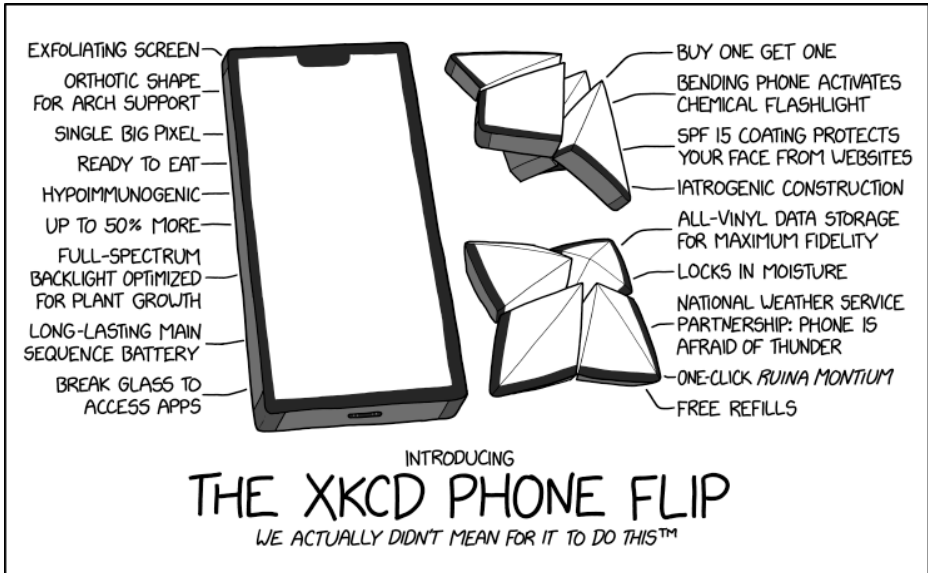
In reality, the electrical supply is standardized within any given country (usually...), but it does vary worldwide, with different countries providing different voltages,

frequency, and outlet shapes. The International Electrotechnical Commission maintains a web site where these differences are catalogued. International travelers often require adapters that will plug into different outlets and may adjust the voltage and/or frequency to one their devices can use, something for which standardization would be much appreciated, although the cost of such worldwide standardization would likely render it infeasible.

Other comics about standardization include 927: Standards, 1179: ISO 8601, 1643: Degrees.

#2831: xkcd Phone Flip

September 20, 2023



Theranos partnership: Sorry, we know, but we signed the contract back before all the stuff and the lawyers say we can't back out, so just try to keep your finger away from the bottom of the phone.

Explanation

This is the 9th in the ongoing xkcd Phone series in which Randall explains his new joke phone designs with many strange and useless features. It is a reference to the somewhat recent Galaxy Z series, but instead of folding in half, it folds into the more complex and much less usable shape of a typical paper fortune teller. (A traditional paper fortune teller requires a square-shaped piece of material; to make this phone with a ~2:1 ratio rectangular shape into a fortune teller, it would first need to be folded in half lengthwise.)

The product's slogan suggests that this was not an intended feature, which would be incredibly difficult to create accidentally without causing the phone to become nonfunctional. It's therefore possible that this phone was designed by Beret Guy's company, which has in the past trademarked seemingly normal phrases and done impossible things with electronics.

The name Phone Flip is a play on the term Flip Phone, which has referred to older cellphones with a basic hinged construction, but Samsung, in particular, has released a line of smartphones under the Galaxy Z range given the name 'Flip' (or 'Fold') which use a flexible display across the hinge, with other manufacturers producing similar technology by other names. Randall's version takes this complexity up a notch with a currently impractical varifolded origami design.

Left column features[edit]

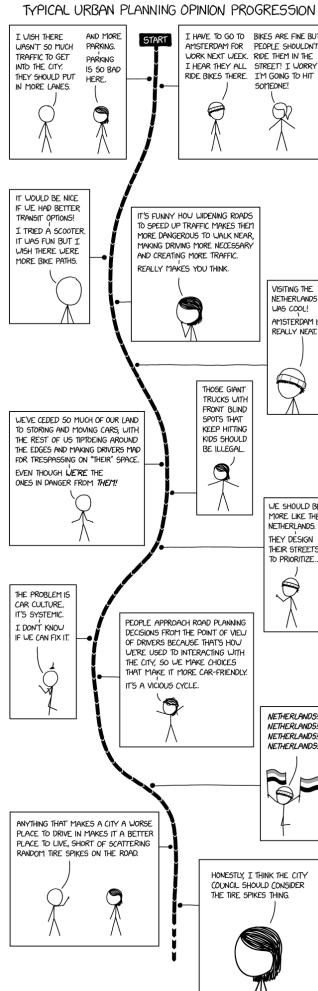
Right column features[edit]

Title text[edit]

The title text references the failed company Theranos that notably could not live up to its promise to diagnose many health issues from a single drop of blood, and was charged with fraud for claiming it could do so. Due to legal agreements, and subsequent design choices already built in, the bottom of the phone will still collect a drop of your blood (unless you're particularly careful).

#2832: Urban Planning Opinion Progression

September 22, 2023



If they're going to make people ride bikes and scooters in traffic, then it should at **LEAST** be legal to do the Snow Crash thing where you use a hook-shot-style harpoon to catch free rides from cars.

Explanation

This comic follows Cueball, Megan, Knit Cap and Ponytail as their beliefs evolve widely from a conventional car-first view of urban planning, then questioning the wisdom of car-centered policies, then favoring pedestrian-centered design, and finally wanting to discourage driving with tactics as extreme as road spikes.

As a clever form of satire, the comic has twin aims:

The first two panels present the conventional view, known as a strawman argument.

- First, Cueball and Megan complain about the common problem many car-centric cities face about not having enough space for all the cars, and they give a conventional suggestion of making more space for cars.
- Next, Knit Cap mentions how she is going to visit Amsterdam, a city known for its walkability and bike friendliness, which gives Ponytail a chance to share the conventional concern that road cycling is bothersome to drivers.
- This is the only moment that anyone pays any attention to Knit Cap; later when she has lived experience of the topic, they ignore her.

In the third and fourth panels, Cueball and Megan begin to evolve their thinking, wishing for better transit and more bike paths – another shortage common in

car-centric cities – with Megan noticing that optimizing for drivers discourages pedestrians, which in turn spurs more driving – later calling it "a vicious cycle."

- Megan's comments could relate to Induced demand, an economic theory in which increasing the supply of a scarce good or service causes the demand to rise faster than the increased supply, worsening the shortage. Traffic is a common example: when US cities try to widen roads and highways, they also incentivize even more vehicles and more driving, worsening the traffic problem. Conversely, other cities have tried removing traffic lanes or converting them to dedicated public transit lanes, and have reported a reduction in traffic congestion, due to people choosing other transportation options. Among urban planners, this is known as the Downs–Thomson paradox.

In the fifth panel – taking place a week or two later – Knit Cap is back from her work trip to report that Amsterdam is really neat.

In the sixth panel Cueball's questioning turns into anger at car culture, beginning his full 180 from his previous, conventional car-centric view as he adopts a strong pedestrian-centric perspective.

- Cities face a dilemma of how to allocate limited street space. Car-centric cities allocate much more public land to vehicle storage and movement, leaving less space for bikes, pedestrians, dedicated transit corridors, greenspace, and density.

In the seventh panel, Megan takes issue with a particular type of vehicle – “those giant trucks” – and their threat to kids. All cars have blind spots in the front, and large trucks have blind spots sizable enough for the truck driver to be unable to see a standing child right in front.

- “Those giant trucks” likely refers to large pickup trucks, though she might be singling out lifted pickup trucks (raised after purchase), large tractor trailer cabs, or garbage/construction-style trucks.

In the eighth panel, Knit Cap's relevant personal observations gets ignored and interrupted by the armchair theorists – a subtle nod to how US policy debates often ignore successful examples from other developed countries.

- As Winston Churchill once said, “You can always count on the Americans to do the right thing after they have tried everything else.”

In panels nine, ten, and eleven, everyone's emotions peak with views that reach their zenith. Car culture is systemic! Driver-centric road planning is a vicious cycle! NETHERLANDS!

By the final two panels, Cueball's and Megan's evolution is complete. Desperate for any fix, Cueball concludes that city livability calls for making the driving experience worse, and then he suggests tire spikes as a solution. The final joke is that Megan actually supports the tire spikes idea, and that this extreme idea emerges from logical

reasoning.

Additionally, Cueball and Megan are coming up with crazy solutions while ironically ignoring Knit Cap's reasonable and practical lessons from how Amsterdam actually solves the problem. This continues the satire of US policy discussions that ignore real-world best practices because they come from across the Atlantic.

- A reader who has been nodding along the whole time may reflect if they agree with Megan's final idea — and if not, why not? The whole comic is a type of logical argument in which many small steps of reasoning can lead to eventually extreme and satirical conclusions, similar to the famous *A Modest Proposal* by Jonathan Swift. It seems that Randall is sharing the evolution of his own views, while self-awarably noting that (1) if you take those views as far as they'll go, you can support some radical implications, and that (2) it's common for Americans to ignore success stories like Amsterdam's.

The title text references a 1992 cyberpunk novel called "*Snow Crash*", by Neal Stephenson. In the future of the novel, the roads are still dominated by motor vehicles, but a subculture of skateboarders exists which uses electromagnetic "harpoons" to attach themselves temporarily to cars. This allows the skateboarders to travel more quickly, by stealing a small amount of momentum from the vehicles. The suggestion here seems to be that such a system (despite being dangerous and chaotic) advantages other forms of transport, at the expense of cars, and is therefore at least somewhat

beneficial.

What are the pros and cons of bike lanes?[edit]

Protected bike lanes are safer compared to painted bike lanes, according to a recent study. It concluded that "protected bike lanes and buffered bike lanes had estimated protective effects on segments between intersections but estimated harmful effects at intersections. Conventional bike lanes had estimated harmful effects along segments and at intersections."

From a wider perspective, however much you attempt to segregate different forms of transport (at junctions and other bottlenecks where space cannot be reserved), you'll always need to bring bicycles and traffic back into contact, briefly, and in circumstances where motorized traffic has become unused to sharing the roadspace with the lighter vehicles. This is unlike a more integrated place like Amsterdam where a driver is rarely going to be surprised by the presence of bicycles, overlook them and therefore cause an accident.

What makes a city walkable?[edit]

To achieve a walkable area, urban planning (or zoning) must be seamlessly integrated with public transport planning. The central truth is that everybody is a pedestrian for some time, which also includes car drivers. Crucially, the average pedestrian is willing to walk about 2000 ft from their home to the next public transport stop, and an additional 2000 ft between the last public transport stop and their workplace. Opportunities for shopping and eating should exist at every connecting station, with the connections scheduled in a way that it both allows changing to the connecting train/tramway/bus immediately – as well as buying groceries.

For an area to be walkable, at a minimum, all roads should have a sidewalk,[actual citation needed] which, of course, costs area, but make the pedestrians' lives much easier and safer. But then, not only roads impact walkability. In the United States, many places open to the public are, by municipal ordinances, forced to provide enough parking space for all customers at any given time, which leads to serious knock-on effects: Pedestrians must often cross a large and weather-exposed parking lot in order to shop. A building can often be only re-purposed if a neighboring building is bulldozed to create the necessary parking area. And tenants who live in an apartment, but do not own a car, are forced to pay for the parking space they do not need. This creates difficulties, particularly in urban areas.

Another topic is subsidizing public traffic. Municipalities in Switzerland, for example, order bus connections – e.g. a hourly bus from 6 AM until 10 PM, and in exchange, they cover the deficit of any such connection. That way, families, who usually are better taxpayers, move to villages, and beginning with grade 5, 6 or 7, pupils can still easily commute to a district school.

#2833: Lying

September 25, 2023



I'M REALLY BAD AT THOSE MAFIA-STYLE
GAMES WHERE YOU HAVE TO LIE.

I was, at least at the start of this disastrous game night,
your friend.

Explanation

Mafia (and other games such as Werewolf) is a party game centered around two opposing teams who must eliminate each other: the mafiosi (or werewolves, accordingly) whose aim is to secretly gain a majority and the ordinary players (who may be termed 'townies' or 'villagers') who have to resist this. While the mafiosi know who are mafiosi and who are villagers, the villagers do not know any other person's role. The mafiosi also need to keep their affiliation secret from the villagers so long as they are outnumbered. The game alternates between day and night phases. During the day, all players vote on which suspected anti-villager should be 'killed' (removed from the game). During the night, all surviving members of the mafia decide which villager should be 'killed' to further their own purposes.

Play can be undertaken in person or across a suitable online forum/group-chat, whilst similar mechanics have been adopted for networked games such as Town of Salem, Among Us and (in combination with other mechanics) Space Station 13.

Here we have Cueball (possibly Randall), Megan, Ponytail, and White Hat sitting at a table, apparently playing this type of game, in which some sort of secret must be maintained by lying. Cueball seems to have been unable to maintain the lie and came clean, perhaps hoping that they would remain friends, somehow fearing that playing the game as required would lose him the

friendship that brought them together to play the game in the first place. The other members are annoyed by his undermining of the basic concept of the game, and White Hat offers to switch to playing another game called Taboo. This may not improve things; given Cueball's apparent inability to maintain secrets, he may feel compelled to tell them the word concealed on his card, and thereby immediately lose.

The title text could both be referring to what Cueball says about how the others are his friends, and also that the others could have gotten so annoyed that they stop being his friends. It is clearly very similar to Spock's dying words in *Star Trek II*: "I have been, and always shall be, your friend".

In reality, Cueball could actually be cleverly playing one of a number of other roles that a mafia/werewolf game can have. There are additional player-types that win by being voted off (often this must be a day-vote, a night-vote by the 'bad guys' is a loss), and others that make the player invulnerable to votes in certain conditions, make the 'kill' act upon another player and/or result in assisting those in a further 'team' of conspirators. Though usually such complications aren't included in gaming groups with as few as four players, and they usually rely on bluff (or multiple layers of bluff) against players who are aware of what they entail.

#2834: Book Podcasts

September 27, 2023



EVERY NOW AND THEN I REINVENT
AUDIOBOOKS FROM FIRST PRINCIPLES.

I've been working my way through this 1950s podcast by someone named John Tolkien called 'Lord of the Rings'--it's a deep dive into this fictional world he created. Good stuff, really bingeable!

Explanation

Randall (represented as Cueball) discusses his love of podcasts, episodic audio files of a talk show. He uses them to pass the time when doing chores. At one point he imagines what it would be like if someone made a podcast narrating books, as an easy and convenient way to digest literature when reading the book yourself isn't an option. As spelled out in the caption, he quickly realizes he hasn't invented a new concept but simply described the existence of an audiobooks, a product which has existed well before the concept of podcasts. It's also worth noting that although podcasts usually involve talking and discussions, podcasts that are essentially chapter-by-chapter audiobooks already exist, as do podcasts that are effectively anthologies of shorter stories, meaning that there's nothing remotely original about his idea.

He confesses this has happened more than once, which as can also be seen in 1367: Installing and 2724: Washing Machine Settings, is not the first time Randall has accidentally reinvented the proverbial wheel for an idea.

"First principles" are the set of propositions that a method or theory is founded on, and which can not be derived from other theories that exist in the field. Therefore, first principles can't be derived from other propositions. In this case, Randall is describing the first principles of audiobooks by working backwards from a medium that was invented later, and that borrowed

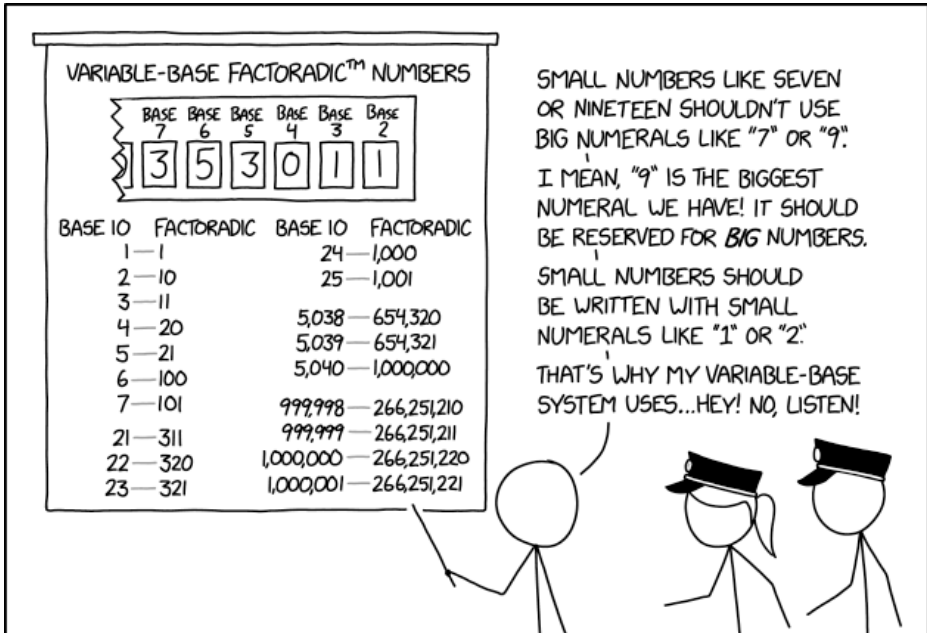
elements from the existence of audiobooks. The humor is in this circular reasoning and anachronistic thought process, as true first principles would probably have involved a real life read-aloud session, and as such is an example of reverse-engineering and not first principle deduction.

The title text is an inverse of the joke, with Randall seemingly having been listening to the Lord of the Rings audiobook without realizing that this "podcast", which somehow seems to have predated widespread audio devices by being released in 1952, was actually originally a book written by J. R. R. Tolkien. This would likely irritate longtime fans of the book (which humorously, would also include Randall).

The words "deep dive" might be referencing the fact that Tolkien wrote the book with the frame story that he was actually just translating the story which was written by the characters in the story, which might also be a joke regarding the reversal of the writing from first principles to "writing" by translation. In addition to this, in 1952, Tolkien's friend George Sayer recorded Tolkien narrating excerpts from *The Hobbit* and *The Lord of the Rings*, later distributed more widely in the 1970s on vinyl records, which this may also be an allusion to.

#2835: Factorial Numbers

September 29, 2023



FACTORIAL NUMBERS ARE THE NUMBER SYSTEM THAT SOUNDS MOST LIKE A PRANK BY SOMEONE WHO'S ABOUT TO BE ESCORTED OUT OF THE MATH DEPARTMENT BY SECURITY.

So what do we do when we get to base 10? Do we use A, B, C, etc? No: Numbers larger than about 3.6 million are simply illegal.

Explanation

A factorial is a product of positive integers. For instance, four factorial, written '4!', means $4 \times 3 \times 2 \times 1 = 24$.

The "base" of a numbering system defines which numbers it uses as digits and what each place value in a number means. For example, in decimal numbers (base 10), the digits go from 0 to 9, and place values are ones, tens, hundreds, etc. So "137" means $1 \times 100 + 3 \times 10 + 7 \times 1 = 137$. Numbers can also be written in other bases, such as binary (base 2, using the digits 0 and 1 and place values of 1, 2, 4, 8...) or octal (base 8, using the digits 0-7 and place values of 1, 8, 64, and so on). Using different bases is uncommon, but is sometimes useful in computer science.

In the comic, Cueball proposes a factorial number system, where the base changes for each place value - the first digit can be 0 or 1, the next digit can be 0, 1, or 2, the third can be 0, 1, 2, or 3, and so on. Each place value is the factorial of the base. So the number 137 in base 10 could be written as 10221, meaning $1 \times 5! + 0 \times 4! + 2 \times 3! + 2 \times 2! + 1 \times 1!$. While this numbering system is technically usable and can express any number, it seems excessively complicated, and the only reason Cueball gives for using it is that he thinks large digits like 9 should only be used in vast numbers (9 would not be used unless the number was at least 9 digits long, or over 3.2 million in decimal). This is a silly reason for using a new numbering system,[citation needed] so the math

department thinks this is a prank, and has security throw him out.

In the title text, someone points out that a factorial number system needs more and more digits for each place value. The tenth digit in a factorial number would be in base 11, which needs 11 possible digits, and 0-9 only provides 10. In bases higher than 10, you can use letters to represent higher digits. For example, hexadecimal (base 16) goes from 0 to 9, then from A to F.

It would be reasonable to do the same thing for higher bases in factorial numbers. Instead, Cueball says that it's simply illegal to write numbers larger than about 3.6 million, the largest you can go without using a base greater than 10. This is an absurd limitation, as other positional numbering systems can go as high as you like, and possibly have room for. (Roman numerals, that use a non-positional system, are said to only go to MMMCMXCIX, or 3999 in decimal, but there are already various ways to exceed this. Practically, the upper limit is still only that of space to write them and any inconvenience in doing so.)

The number at the top of Cueball's presentation, 353011, is $3 \times 6! + 5 \times 5! + 3 \times 4! + 0 \times 3! + 1 \times 2! + 1 \times 1!$ which gives the decimal value of 2835, the number of the comic.

Cueball's examples of numbers written in factored appear as sequences A007623 in the OEIS.

#2836: A Halloween Carol

October 02, 2023



[after a minute] "Okay, I think I've got it, thanks. Can I--"
"oOoOoOoOoOoOo!"

Explanation

In the classic and widely-adapted Charles Dickens story *A Christmas Carol*, the protagonist of the tale is visited by various ghosts, first that of his old business partner and then (successively) the spirits of Christmases Past, Present and Yet To Come. Their purpose is to rehabilitate him from his anti-Christmas ways of apathy, indifference and general cruelty to the weak and poor. By their intervention they generally improve his humanity and spiritual future by showing him how he came to be this this way (Past), how he is seen right now (Present) and what his future would be if he continues down that road (Yet to Come), and thus rekindling his capability of love, humility, and kindness.

In this case, however, three Halloween-style ghosts arrive as a spoof of that tale. They represent similar phases of the actual festival of Halloween, but have turned up to pester Cueball in his bed all at the same time. And the 'lesson' they convey to him is far less transformative in nature. Since the ghosts say nothing more than minor variations of "oOOOOOOOOOo," the lesson may be that Halloween has no "true meaning" other than what is obvious (compare 1108: Cautionary Ghost), or that the true meaning of Halloween consists merely of the kind of silly "scariness" represented by the sound "oOOOOOOOOOo". Additionally, since Halloween is typically represented by ghosts, the ghosts only have to exist as themselves to spread the "true meaning of Halloween" (as opposed to the various Ghosts of

Christmas, as Christmas is not so directly associated with ghosts).

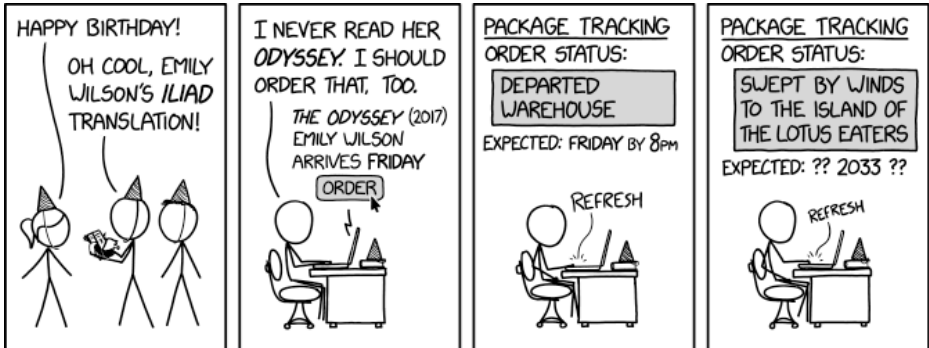
Caroling, though these days almost exclusively associated with Christmas, had long been a term for festive songs and dances. Arguably, it is largely through Dickens's use as his story title that we associate it so strongly with this particular annual festival, which might be another additional joke on Randall's part.

A similar ghost saying "ooOOOOOOOOooo", along with much scarier things, appears in 1393: Timeghost.

In the title text, it would appear that the very simple message has been received and taken to heart, but the apparitions feel the need to continue their haunting regardless. This is something that might be further associated with Halloween, because annoyingness is a staple of Halloween (as it is of life in general).

#2837: Odyssey

October 04, 2023



Ugh, it says they attempted delivery but "Nobody was home."

Explanation

In this comic Cueball receives a birthday present from Ponytail: a translation of the Iliad, by Emily Wilson. The Iliad is an Ancient Greek epic poem authored by Homer about the 10-year long Trojan War which involved some of the most noteworthy warriors and leaders of that age. Wilson published her translation of the Iliad in September 2023, several weeks before the release of this comic.

Cueball then orders the Odyssey, Wilson's earlier translation of another well known epic poem of ancient Greece. In the story, a hero of the Trojan War named Odysseus journeys home. Wilson published this translation in 2017, to great acclaim, for various reasons, one being that Wilson was the first translator into English who used words that showed the original connotations better (such as 'hounded' instead of 'bitch' and slaves instead of servants).

At the start of his journey in the Odyssey (which takes place in the middle of the poem in a flashback, as the epic starts in *media res*), Odysseus and his crew are blown off course, and instead arrive at the island of the Lotus-Eaters. This begins a string of misfortunes and adventures which result in it taking another 10 years before Odysseus would make it home. In the comic, the same initial fate befalls the book delivery, and in expectation of a similarly tortuous journey, it is projected to arrive in 2033, 10 years after Cueball ordered the

book, instead of the original 2 days (assuming that the day of ordering is the same as the day of the comic's release).

Package delays are not uncommon, and tracking websites can often cause more frustration than comfort and enlightenment, thanks to obscure status updates, and repeatedly deferred 'expected' delivery dates. However, anticipated 10-year delays, and status changes due to weather conditions and blissed out islanders are a bit more rare. The implication is that the package carrier was at sea after departing the warehouse and found themselves swept onto the island and ate of the lotus flower, causing them to not want to leave and continue the delivery.

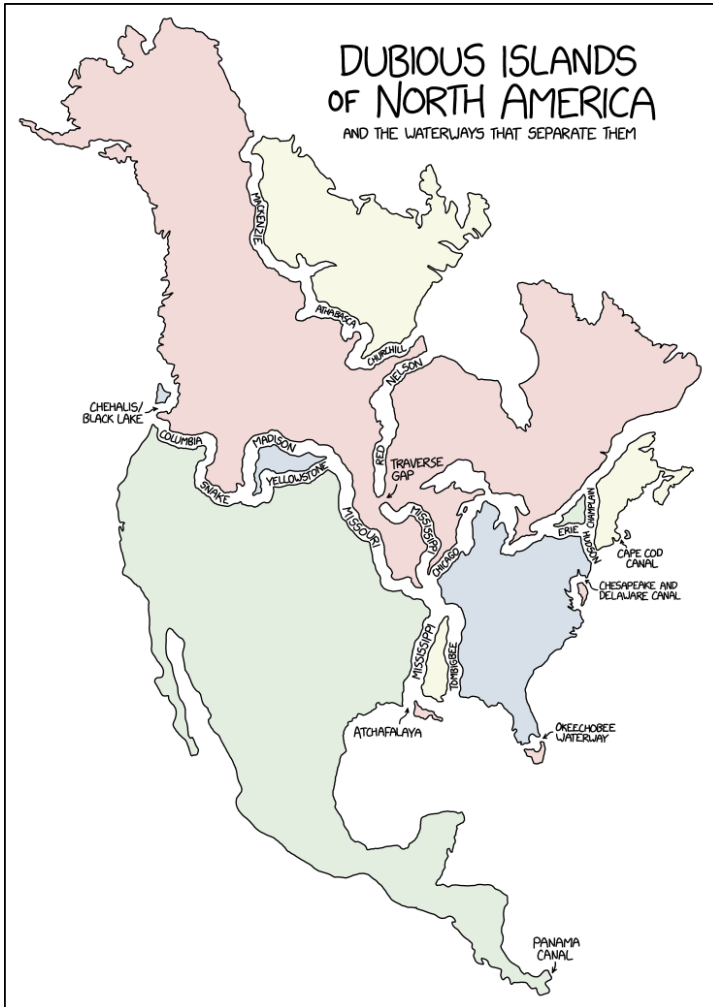
The title text refers to a moment in the *Odyssey* when Odysseus escapes from the cyclops Polyphemus. Odysseus, when introducing himself to Polyphemus, gives his name as "Nobody" (or in Wilson's translation, as Noman). After Odysseus has drugged him with drink and blinded him, the Cyclops cries out that "Nobody is attacking me!" Hearing this, Polyphemus's cyclops neighbors (quite reasonably, seeing that he is also drunk) misinterpret his words as meaning that nobody is attacking him (and therefore he is not being attacked), believe there is no reason to help and return to their homes, allowing Odysseus and his remaining crew to escape.

A frustration that is sometimes experienced by those awaiting packages is that a tracker will update to claim that the item couldn't be delivered because there was

no-one available to receive it, despite having waited in for it at the appointed time, presumably because the courier falsely recorded an attempt in order to skip having to make the delivery. In this case, though, the suggestion is that someone named "Nobody" was at the delivery address, and when the package carrier (or automated delivery robot) approached the front door, and was told that "Nobody is home", they decided not to deliver the package, much to Cueball's chagrin. The frustrations of e-commerce have previously featured in 281: Online Package Tracking.

#2838: Dubious Islands

October 06, 2023



Running for office in Minnesota on the single-issue platform 'dig a permanent channel through the Traverse Gap because it will make this map more satisfying.'

Explanation

The definition of "island" is a piece of subcontinental land completely surrounded by a body (or perhaps bodies) of water. In most cases we don't count rivers and canals as the surrounding bodies,[actual citation needed] although small pieces of land like Manhattan are exceptions, as is any bit of land entirely surrounded by the same watercourse, that splits around it. Inland islands surrounded by rivers can be called a "holm".

In this comic, however, Randall considers various large parts of North America as "dubious" islands because they're separated from other parts of the continent by various major rivers, canals, and large lakes. The repetition between the title "Dubious Islands" and the in-image label "Dubious Islands of North America" emphasizes the "Dubious-ness" of this map.

Randall's map's "Dubious Islands" are indeed not to be trusted — they leave out many less prominent rivers and canals which would break the map into many more additional "islands". For example, southern Nova Scotia, southern New Jersey, and the nearly 60-mile-long "Grand Strand" of South Carolina are also islands by the sense used here in recognizing the Cape Cod Canal as creating an island. These and many other omissions would be errors — except that Randall clearly labelled his islands "Dubious" (not to be trusted) from the start, and he is presumably well-aware of this map's stretching of reality.

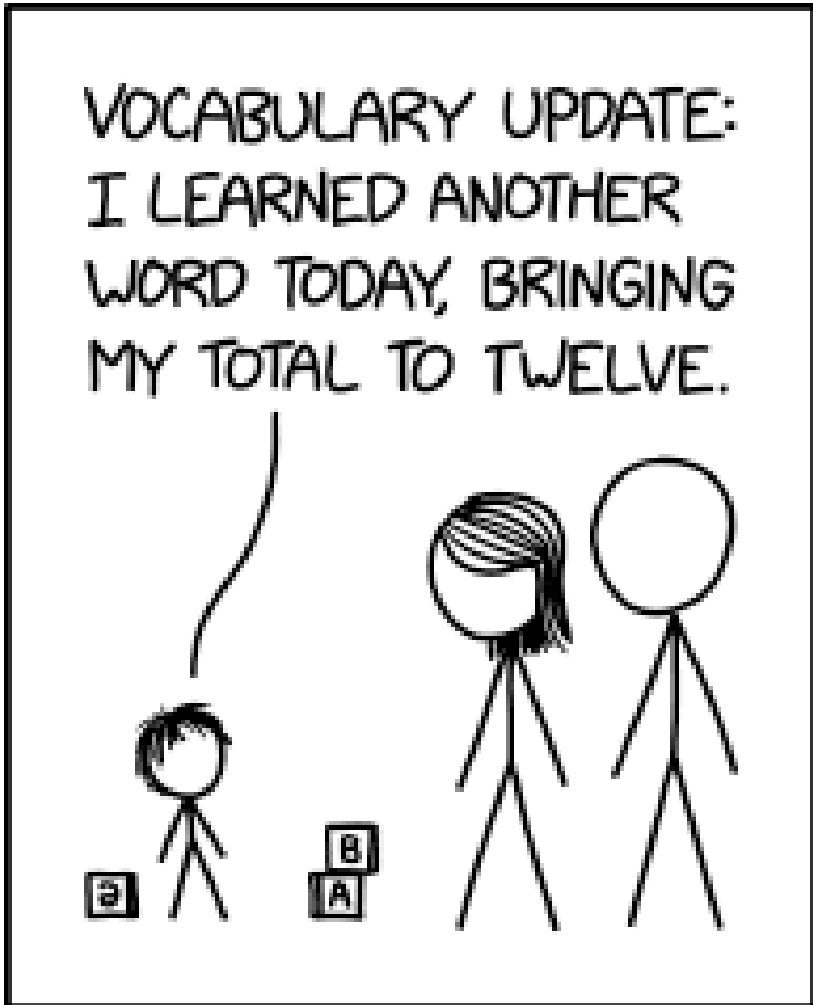
The geography around the area known as Parting of the Waters explains the connection between the Yellowstone and Snake Rivers shown. Isa Lake drains into both the Snake River (via the Lewis River) and the Madison River (via the Firehole River), explaining the connection there. It is unclear why Divide Creek, which connects Hudson Bay to the Columbia River, or Committee's Punch Bowl, which connects the Arctic Ocean with the Columbia River, are not shown on this map.

The title text suggests that the map could be improved by digging a canal through the Traverse Gap, thereby splitting the large red "island" into two smaller "islands" with more pleasing shapes. Randall proposes to run for office in Minnesota (where the Traverse Gap is located) on the platform of digging this canal. This is unnecessary and would create little benefit to residents,[actual citation needed] but constituents who like interesting maps might vote for him.

These islands are possibly Randall's humorous interpretation of the possible effects of drastic erosion (perhaps caused by continued climate change) inducing increased water movement. Sea level rise might also provoke some of these disconnections, but as some of the connecting waterways exist at over 7000 feet (over 2km) in elevation, this would require a worldwide rise in sea-level (and/or localised fall of land) that would cause other changes to the map of North America.

#2839: Language Acquisition

October 09, 2023



My first words were 'These were my first words; what were yours?'

Explanation

Language acquisition is the process by which humans, generally infants, learn a language. There are many theories as to how this process works, but Randall humorously conflates an infant's language acquisition process to an adult's, saying that infants learn languages one new word at a time. This could be equated to how app-based language learning works, at least at certain stages of vocabulary expansion. This is typically not true[citation needed] for infants learning the native language(s) that they will consider as their mother tongue.

The child's sentence says that he has acquired another word, bringing his total to twelve words, all unique. This is conveyed in the twelve unique words spoken, thus indicating (if true) that these are the very (and only) words the infant has acquired up to this point. These would be a very unusual set of words to be the first ones learned for an infant (and even for an adult, deliberately acquiring a new language). Furthermore, the child appears to have learned some fairly advanced grammatical concepts in order to construct this fairly complex sentence, similar to how adults may start with somewhat advanced grammar rules as they start to assemble the knowledge of a new language. Learning grammar typically takes much longer, and only occurs makes sense once sufficient vocabulary has been learnt to recognise the patterns in how the words are used.

Interestingly if this sentence is true, the child has learned the word "twelve" before learning the words for any other numbers, and so could not have given a quantitative update on previous days. However, this would also imply that their counting is not yet as advanced as their language acquisition, which may mean that they are simply wrong about the number of words they have learned.

In fact, it is possible to create a "learning sequence" based on these twelve words to somewhat make a little sense if the words are acquired in a word-after-word basis. An example is shown below:

- Word!
- Another word!
- Learned another word!
- I learned another word.
- I learned another word today.
- Update: I learned another word today.
- Vocabulary update: I learned another word today.
- My vocabulary update: I learned another word today.
- I learned another word today to update my vocabulary.
- I learned another word today to update my total vocabulary.
- Bringing another word I learned today to update my total vocabulary.
- Vocabulary update: I learned another word today,

bringing my total to twelve.

Two letter-blocks on the ground next to the child show capitals 'A' and 'B', and a third has an upside-down lowercase 'e'. The block with the 'e' may indeed be upside-down, but it could also be a block with the phonetic symbol schwa on it. As phonetics are generally used by lay-people when they start to learn how different sounds in their target language is pronounced, this would suggest the parents are teaching their child advanced linguistic concepts before they've fully learned to speak their first language, which might explain why the child's language acquisition is so unusual.

The title text makes a self-referential joke about the concept of "first words", where a supposed child discusses one's own first words in a complete sentence. There are seven unique words in the title text, most of which do not appear in the comic image, suggesting the title text and comic image referred to two different children. It is a common milestone to celebrate a child's "first word", but typically these would be less advanced words, such as "mama" or "dada".

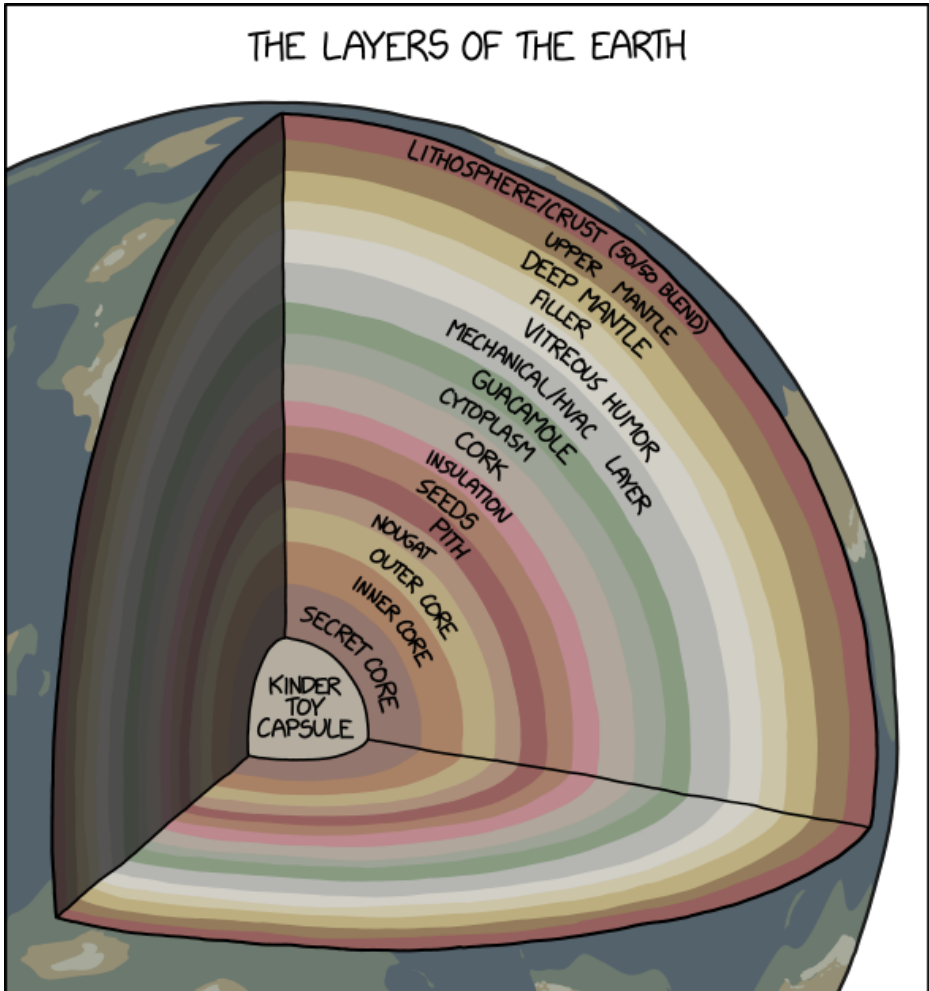
This seems to be another indication that Randall is conflating adult language acquisition and infant language acquisition, because such moderately-complex sentences are usually a beginner's first attempt in a new target language, by the way of learning set phrases by rote (for concepts they can already voice in another language). Examples might include standard greetings, such as "Hello, my name is [...]", and various questions and

answers related to their exposure to the foreign language concerned.

2567: Language Development has had a similarly obscure take on language acquisition.

#2840: Earth Layers

October 11, 2023



The Earth's magnetic field is primarily generated by currents in the liquid outer core, though some geophysicists argue that an unexplained mismatch with models suggests that the Kinder toy contains a magnet.

Explanation

This comic reimagines the internal structure of the earth, mixing the real geological layers of the planet with fictional ones. Some of the fictional layers are appropriated from the layers of other objects that have cross-sectional diagrams, such as the layers of a piece of fruit, an eyeball, an item of confectionery or a building.

The title text alludes to how kids like to guess what toy might be inside their Kinder treat. In this case, "some geophysicists" can do more than guess; they can infer that the Kinder toy core has a magnet (a popular type of toy) because it would explain a mysterious "mismatch" of current magnetohydrodynamic models not fully explaining observable phenomena. In this scenario, Earth's geomagnetic field is amusingly explained to be generated both by currents in the liquid outer core as well as the contents of the Kinder Toy Capsule core.

The text refers to a single Kinder toy, which is presumed to be huge, scaled to the size of the Earth's core, and to contain a proportionally-sized magnet.

As a thought experiment though, if we assume that the "Kinder Toy Capsule" actually contains multiple normal-sized Kinder Eggs, there would be approximately 50 sextillion of them. Here's the math:

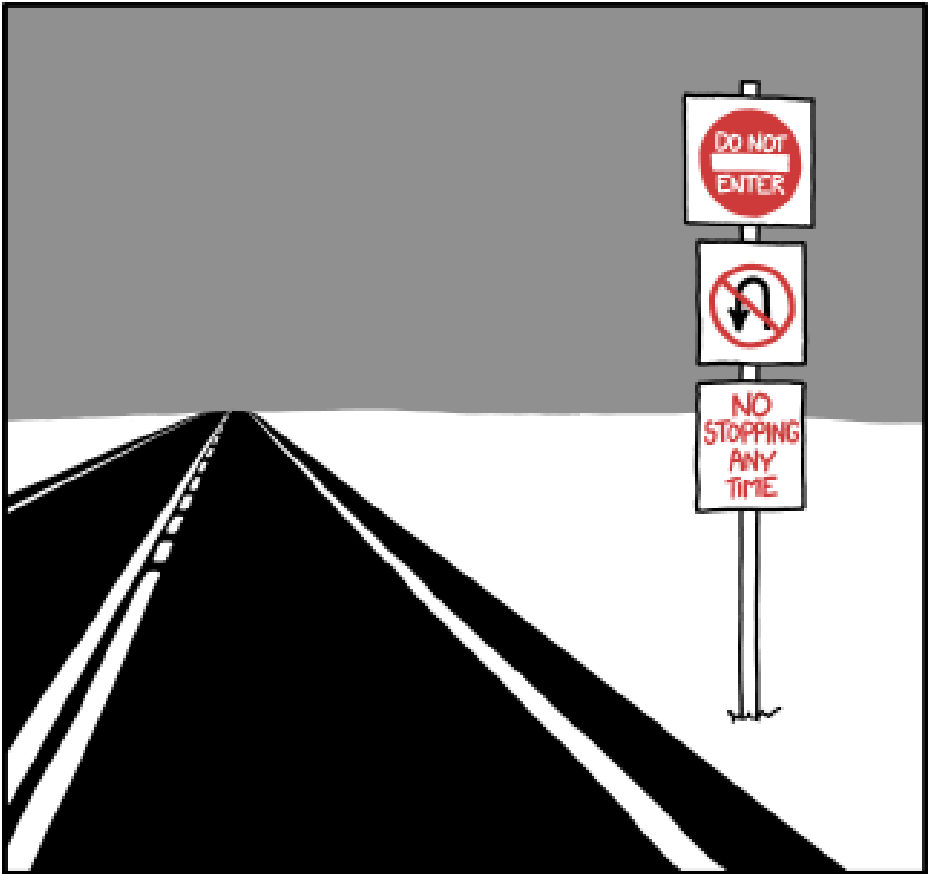
- The mean radius of the earth is 6371 km
- If the diagram is to scale then measurement of it gives

the Kinder Toy Capsule a radius of about 900 km.

- This gives the Kinder Toy Capsule a volume of just over 3 billion km³.
- Assuming a real Kinder Egg has a volume of 60 cm³, and a packing density of 63.5%, the Kinder Toy Capsule could contain 5×10^{22} (50 sextillion) actual Kinder Eggs.
- (Current magnetohydrodynamics models of the Earth's core fail to contemplate the contribution of 50 sextillion Kinder Toy Capsules.)

#2841: Sign Combo

October 13, 2023



OH NO.

Speed Limit: 45 MPH / Minimum: 65 MPH

Explanation

This comic depicts a trio of road signs that provide legal instructions that are, in combination, impossible to follow: "Do not enter" precludes passing the point of the sign, the No U-Turn sign precludes turning around, and the "No Stopping Any Time" sign precludes both halting before the sign as well as reversing back (even ignoring that this is usually already illegal with or without signs explicitly forbidding it). A driver approaching this sign combo would seemingly be forced to violate at least one of the three, probably leading to the caption's concern expressed as "Oh no".

Of the three, "No U-Turn" is the one with the largest wiggle room, as it can be defined more narrowly/specifically as driving in a U-shape; thus, a driver might be able to get around it by drawing a more elaborate path. However, since the lane dividers on the road are solid until the signs, this potential loophole is preemptively closed.

Depending on the jurisdiction, signs may only apply to the road after them, so you could validly stop just before it.

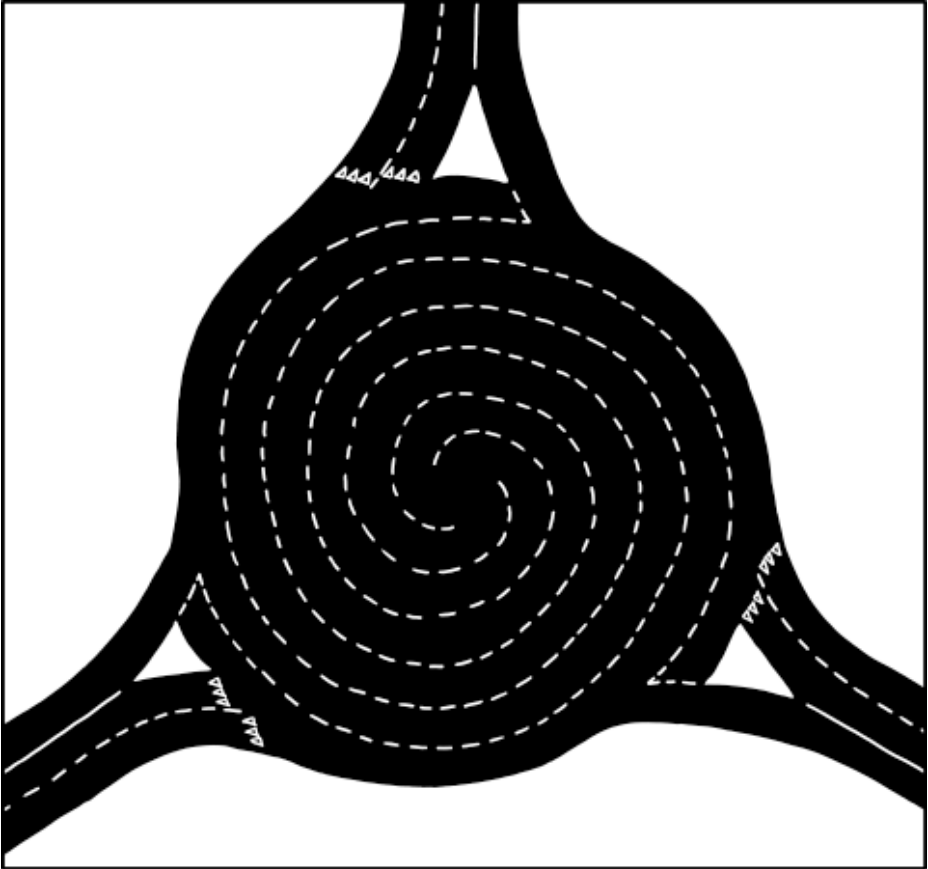
This no-escape scenario could be done more easily with just "Stop" and "No Stopping Any Time" signs. But by combining 3 signs, the joke is presumably that it was done accidentally, without noticing the contradictions.

The title text adds even more to the dilemma, posting a 45 miles-per-hour maximum speed limit, but also a minimum required speed of 65 MPH. Since 45 is lower than 65,[citation needed] this is quite the perplexing contradiction.

For another of Randall's adventures in road signage (he does live in the Greater Boston area, after all), see 1116: Traffic Lights. For a similar contradiction, see the title text of 2179: NWS Warnings.

#2842: Inspiring Roundabout

October 16, 2023



EVEN THOUGH IT *WAS* TECHNICALLY NAVIGABLE, THE HIGHWAY DEPARTMENT VETOED MY INSPIRALING ROUNDABOUT DESIGN.

Look, I just think we need to stop coddling those hedonistic roundabout hogs who get into the inner lane and circle for hours, wasting valuable capacity.

Explanation

This is the second consecutive comic that deals with confusing directions given to road users.

A roundabout, a form of traffic circle or rotary, is a traffic control device that serves as an alternative to stop signs, instead allowing for mere yields, as all traffic flows in the same counterclockwise direction around a central point (clockwise in left-hand traffic countries). Roundabouts improve safety and the flow of traffic, since they eliminate turns against traffic and full stops are only needed during high-traffic periods. One downside is that they take up more space than a traditional signaled intersection.

Various roundabout designs have been proposed and used throughout the world. Some use "out-spiraling" designs in which a driver wishing to access one of the furthest exits is initially directed into a lane towards the center, which then spirals outwards, guiding them out until they reach the intended exit. Randall, in contrast, proposes an "Inspiring Roundabout" which spirals each entrance lane inward, eventually leading all three roads to meet in the center and become the exit lanes.

The caption states that it's "technically navigable", but that the Highway Department has vetoed it, presumably because of its deliberate complexity, impracticality, and the high risk of head-on collisions.

The system is fairly simple to use. Assuming left-hand driving / right-hand traffic, one could get to the next exit without entering the spiral. Getting to the subsequent exit would simply require making a lane change toward the right.

However, Randall is likely assuming drivers who don't change lanes, in which case his design would force drivers to travel ever deeper into the spiral, reach the center, and choose one of the other two lanes to attempt to exit the roundabout.

If vehicles don't change lanes, head-on collisions would be likely in a few scenarios, such as two vehicles reaching the center at the same time, or two vehicles trying to use the same lane going in different directions, one outspiraling from the center and one inspiraling from the entrance, eventually meeting each other head-on. (In this design, each inspiraling entrance lane can also be used as an outspiraling exit lane.)

The joke is that such a deliberately challenging and dangerous design would be unlikely to be approved.

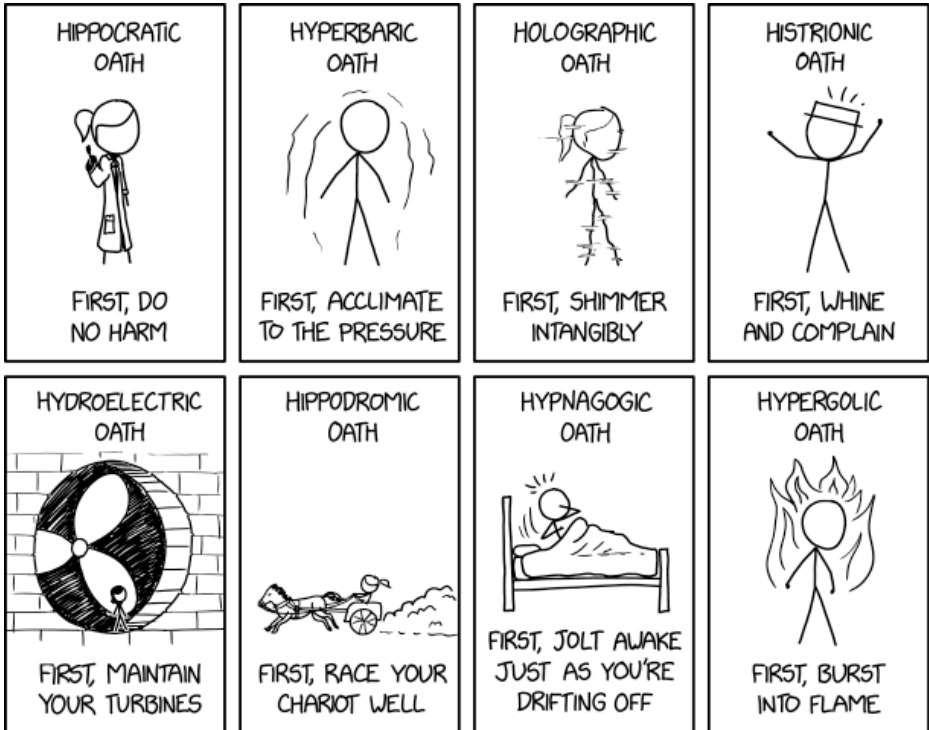
The title text justifies this creative design by manufacturing an amusing problem of "coddling hedonistic roundabout hogs who get into the inner lane and circle for hours". Of course, it's unlikely (but not unheard of) that anyone would deliberately spend more time than necessary (let alone hours) circling a roundabout, so this design proposes to solve a non-issue. In reality, if someone finds themselves deeper into or

longer in a roundabout that they need to be, it's more likely to be a misunderstanding of how roundabouts work and confusion about how to get out of them rather than a hedonistic "doing it for the thrill" rush.

- In street racing culture, doing "donuts" -- circling a single spot at high speed to leave circular tread marks on the pavement -- is a popular pastime, but these drivers circle for a few rotations, not several hours.
- The complaint of "coddling" some group was popularized by the title of the 2018 book, "The Coddling of the American Mind," a criticism of modern higher education.

#2843: Professional Oaths

October 18, 2023



Interpretations of the Hermeneutic Oath differ.

Explanation

The Hippocratic Oath is an "oath" of ethics taken by medical professionals, which includes the phrase "do no harm". Technically, the exact phrase "first, do no harm" is not in the oath, but this meaning is implied.

The full Hippocratic Oath can be seen at the Wikipedia article.

Randall takes other words that sound similar to "Hippocratic" and creates "oaths" for them.

- Hyperbaric means "of, relating to, or utilizing greater than normal pressure", so thus a "hyperbaric oath" would indeed involve getting used to (acclimating to) a different pressure.
- Holographic refers to "holographic" projections as seen in media such as Star Wars, in which the image typically shimmers. Not to be confused with actual holograms.
- Histrionics is "exaggerated, overemotional behaviour, especially when calculated to elicit a response".
- Hydroelectricity is producing energy using water power, typically using turbines.
- A hippodrome is an arena that was historically used for chariot racing and horse racing.
- Hypnagogia is "the state immediately before falling asleep". The phenomenon of jolting awake just as one is about to fall asleep is sometimes referred to as a hypnagogic jerk. According to 371: Compiler

Complaint, this is essentially the human equivalent to a segfault.

- A hypergolic propellant is a type of rocket propellant which doesn't need a spark to ignite, and spontaneously combusts when mixing the parts together. Normal rocket propellant, such as RP-1 and liquid oxygen, requires some sort of initial spark to start the reaction.
- (title text) Hermeneutics is the study of interpreting texts, thus the "Hermeneutic Oath" could have several interpretations as to its meaning.

#2844: Black Holes vs Regular Holes

October 20, 2023

	BLACK HOLE	REGULAR HOLE
USUALLY FORMED BY...	SUPERNOVAS, COLLIDING STARS	SHOVELS, SMALL MAMMALS
FALLING IN IS...	DEFINITELY FATAL	SOMETIMES FATAL
CREATED BY THE BIG BANG	MAYBE	NO
CREATED BY CHILDREN PLAYING AT THE BEACH	I REALLY HOPE NOT	YES
SOURCE OF MANY PRECIOUS METALS	INDIRECTLY	YES
EINSTEIN IMAGINED FALLING INTO ONE	YES	PROBABLY AT LEAST ONCE
A COMPONENT OF DARK MATTER	MAYBE	PROBABLY NOT
CREATED BY THE LARGE HADRON COLLIDER	NO	YES
MASSIVE STARS OFTEN COLLAPSE INTO THEM	YES	NO
EXPLORED BY HUMANS IN FAMOUS SCI-FI STORIES	YES	YES
FATAL TO GET A BIG ONE IN YOUR BODY	YES	YES
SOME OF THEM ARE THE MOUTHS OF WORMHOLES	MAYBE	YES
STEPHEN HAWKING AND KIP THORNE ARGUED THAT ANY INFORMATION THAT FALLS INTO THEM IS LOST FOREVER	YES	NO
COMMONLY INHABITED BY MEERKATS	UNDETERMINED	YES

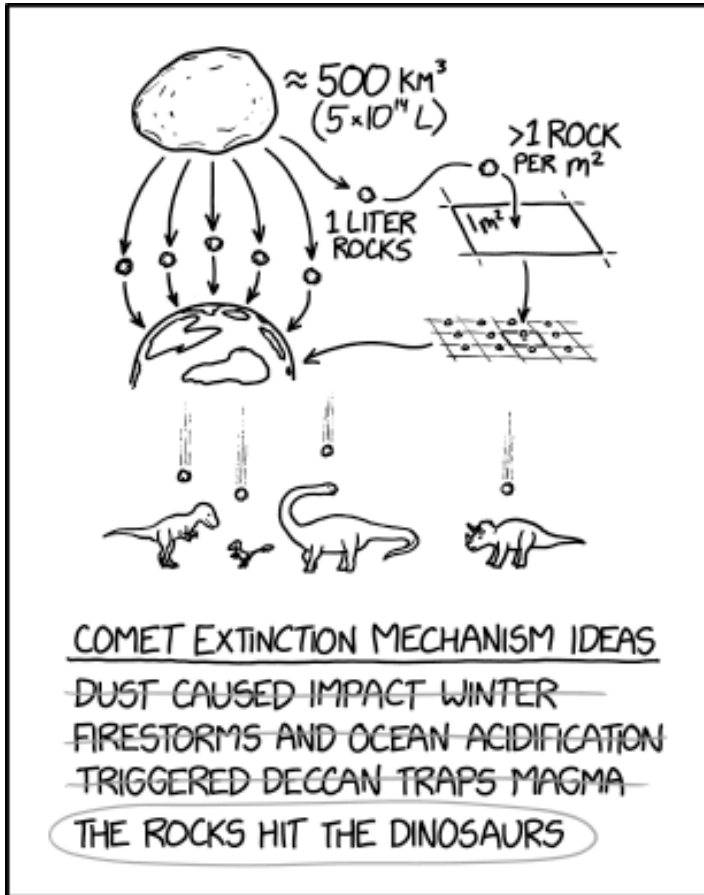
Created by the collapse of: [massive stars] [Florida limestone bedrock]

Explanation

This comic is a comparison between black holes and regular, everyday holes.

#2845: Extinction Mechanisms

October 23, 2023



PALEONTOLOGISTS ARE MISSING
THE OBVIOUS ANSWER.

The Late Heavy Bombardment was followed a few billion years later by the Comparatively Light but Oddly Specific Bombardment.

Explanation

Around 66 million years ago there was a mass extinction event responsible for the extinction of all non-avian dinosaurs. This is why there are no more dinosaurs (except for birds!) There have been a number of explanations for this, but most currently accepted explanations center on the Chicxulub impact, in which a large asteroid (the comic suggests it was a comet) hit the Earth. The exact mechanism for the extinction caused by this event, however, is not clear. The comic suggests three possibilities: impact winter caused by dust released from the impact, firestorms along with ocean acidification from acids generated by the impact, and the enhanced eruption of volcano(es) in the Deccan Traps region in India. Here all three possibilities have been crossed out and a fourth one, "the rocks hit the dinosaurs," is circled as the correct answer.

The argument is that the comet had a volume of 500 km³ (10 km diameter), or 5×10^{14} L. Earth has a surface area of around 500 million km², or 5×10^{14} m². The idea is that the comet broke up into liter-sized rocks, so that there were sufficient of these to fall, on average, one on every square meter of surface. Somehow, these rocks managed to fall in a distribution such that they directly hit each of the dinosaurs, but presumably did not hit the other forms of life that did not go extinct. It is unclear how such a breakup or scattering might have occurred – a body that passes within Earth's Roche limit will eventually break up into a ring, but this limit is generally

a single-digit multiple of the planet's radius, so an object on an inbound collision course would only experience high tidal forces for a matter of minutes before impact.

The title text refers to a hypothetical event early in Earth's history, ironically known as the Late Heavy Bombardment, in which a number of asteroids struck the Earth and other terrestrial planets around 4 billion years ago. The mass extinction event of 66 million years ago is then referred to as the "Comparatively Light but Oddly Specific Bombardment", presumably because it isn't as heavy as the LHB, but oddly specific in its targets.

#2846: Daylight Saving Choice

October 25, 2023



THE GOVERNMENT FINALLY
DECIDES TO PUT AN END
TO ALL THE ARGUMENTS.

I average out the spring and fall changes and just set my clocks **39** minutes ahead year-round.

Explanation

Daylight saving time (DST) is a practice best known for changing the clock one hour ahead (though two hours offset have also been used, using a combination of an all-year DST and a seasonal DST) for approximately half the year, typically from spring to autumn. Countries nearer the equator do not see significant changes in daylength between winter and summer and so have rarely had a reason to follow this practice. A number of countries which used to follow this practice no longer do, and a few now follow year-round DST – however summer-only DST is still used in North America, Europe, and parts of South America, Oceania, Africa and Asia.

Within countries that still follow this practice, there are frequent arguments (mostly during the 2-3 days surrounding the clock change) over the pros and cons of it. Black Hat is suggesting that everyone should observe or ignore daylight saving time based on their personal opinion. While it might put an end to the arguments (although this itself is debatable) it would clearly cause disharmonious time. This would eventually break the population into at least three categories: those who do not follow daylight saving changes and choose to remain on "daylight" time year round; those who do not follow and choose to stay with "non-daylight" time year round; and those who readily switch to daylight saving time during the prescribed period (and might also include those who follow the suggestion provided in the title

text). There would probably also be a further 'group' who choose to change their clocks on an arbitrary date and time that suits them. So, some people might think it's 8:00 while others think it's 9:00, or vice-versa, but the relative number of people who believe it is each time would shift throughout the year. This would lead to many scheduling errors, delays, and other mistakes, resulting in widespread inconvenience and harm.

The joke here is that, while most options in life can be left to individual choice, clock time is only fully useful if everyone involved agrees on what it means, which is also the reason countries began standardizing the time by regions, instead of people using the local time of their town. There may also be a humorous reference to the confusion already often caused around this time when countries do not all begin or end DST on the same date, for example in scheduling calls or online meetings between Europe and North America in the week after publication of this comic.

There are known incidents in which an actual application of Black Hat's proposal rendered a terrorist plot void. One of them is a 1999 Darwin Award Winner

This comic was posted 4 days before the end of 2023's daylight saving time in most European countries, and 11 days before the end of 2023's daylight saving time in most of North America. If the proposal is actually instituted at this time, those in the Northern Hemisphere

who do not like the fuss of changing their clocks would remain on DST (as has been actually proposed), yet those who are happy with it will fall back to non-DST over the winter months. Presumably, unless anyone changes their minds over the 'winter' period, everyone would actually be back in sync for future 'summer's.

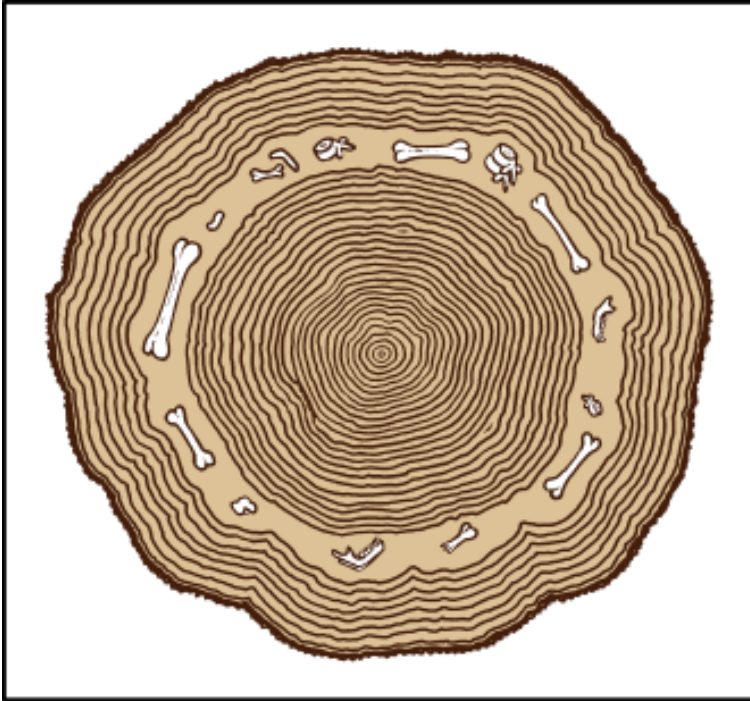
However, the rule (as spoken by Black Hat – not known for being imprecise, or unintentionally misleading) does not restrict people to merely choosing whether the daylight offset is personally used during DST periods. It instead seems to impel them to undertake (or not) the statutory changes according to personal convictions, perhaps contrary to what their convictions actually desire. It is left open-ended ("From now on...") if people from both mindsets can arbitrarily change their minds in the future. If they can, and act accordingly, this time next year there could be people on three different 'summertime' offsets: zero (change now, but not change later), +1 (steadfast change/no change) and +2 (don't change now, but shift forward in spring). Beyond next year's "fall back" date, there could be people on -1 (fall back, don't spring on, fall back further) and each full year beyond may add additionally positive/negative extremes of offset by those who periodically change their inclinations to only obey one of the relative imperatives, and a potential standard distribution of everyone else between. All this could just be a badly worded explanation of the policy, or even in the wording of the legislation behind it, but the presence of Black Hat at the lectern probably indicates that he fully expects and

intends such a boding and expanding chaos.

The title text suggests splitting the difference by using a constant offset which is the average of the daylight saving offset across days of the year. This will create additional problems, primarily because offsets of 39 minutes are unusual (most offsets are by hours and even the least common ones are offset by the multiples of a quarter of an hour), as well as being of not much use, as only a fraction of the daylight will be saved in this way. We also do not know if in this system Randall would change his clock for the leap year to account for the additional day.

#2847: Dendrochronology

October 27, 2023



DENDROCHRONOLOGISTS CAN DATE WOOD
SAMPLES BY IDENTIFYING GROWTH RING
ANOMALIES THAT CORRESPOND TO SPECIFIC
EVENTS. FOR EXAMPLE, IT'S OFTEN POSSIBLE
TO SPOT THE HORRIBLE SUMMER OF 1635
WHEN TREES TURNED CARNIVOROUS.

These anomalies are known as Miyake events, named for the pioneering scientist who discovered them and was tragically devoured by a carnivorous tree.

Explanation

Dendrochronology is a scientific method of using tree rings to tell the age of a tree and learn about historical climate from features found in each ring. It's based on the fact that trees add a new ring each year, so counting the rings will tell a tree's age in years. Additionally, climate and ecology affect the size and composition of each year's ring, so scientists can use rings to estimate what conditions were like each year. They can cross-compare tree-ring samples from overlapping date ranges, of comparable trees grown and felled at different times, to build up and confirm a useful ring history well beyond that of a single tree.

In some cases, tree rings contain remnants of specific events, such as forest fires, large volcano eruptions, atomic tests or droughts. Extremely disparate years can often be seen represented by a clear visual change in the usual subtle variation of ring-growth. The comic posits that, in 1635, trees somehow became carnivorous. The ring for that year contains indications of the bones of the creatures that they ate. This was just a temporary condition, since the rings after this have no bones, but clearly was a coordinated event among different trees to have caused this to be a comparable marker. Events such as this may have reoccurred at other times, just not again/before within the lifetime of the particular tree illustrated.

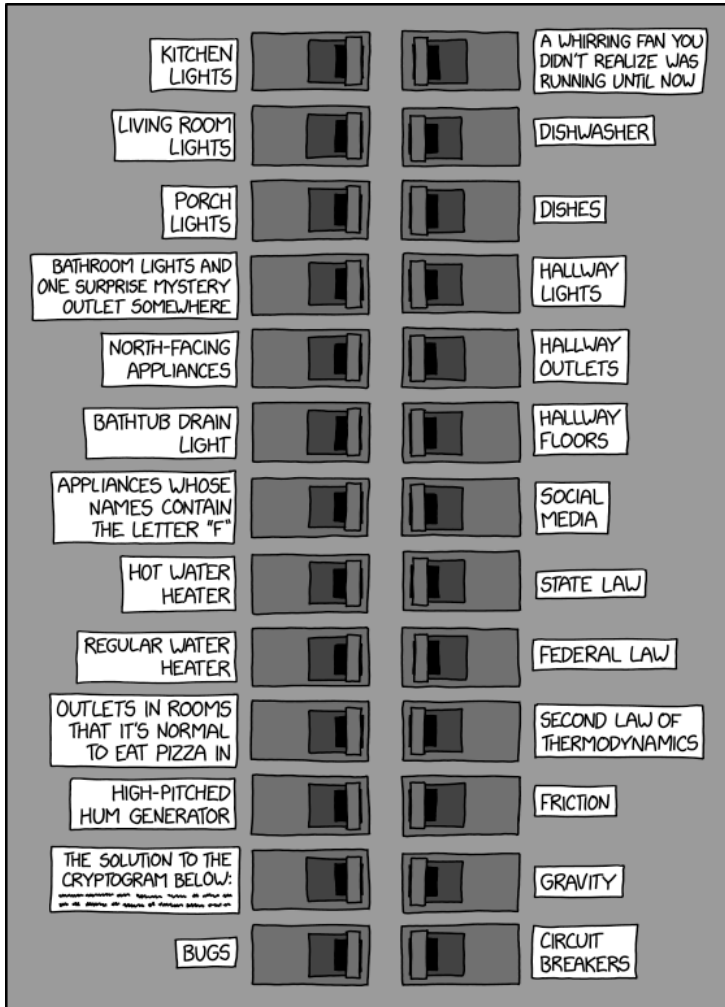
The title text says that anomalous years like this are called

'Miyake events', after a scientist named Miyake who discovered them (and was subsequently eaten by the trees, similar to the origin of Thagomizer). In actual fact, a Miyake event is a period when a larger-than-normal quantity of certain isotopes are created by cosmic rays, possibly due to extreme solar flares. Evidence of these events can often be found in ancient tree rings, as physicist Fusa Miyake discovered when investigating tree rings from years 774-775. However, she wasn't then devoured by the trees – certainly not in 1635, which is centuries prior to her 2012-13 publications.[citation needed]

A surprising number of things can be actually found within the 'flesh' of trees, though mostly inorganic items (e.g., metal tools) that are placed and abandoned there long enough for the tree to expand its bark and woody trunk around them. Skeletal remains are more often found in the roots of fallen trees. They are mostly[actual citation needed] from bodies that were there before the tree started to germinate, or perhaps even were buried and then a tree deliberately planted to either mark or obscure the burial site. It is even possible that the young tree significantly benefits from nutrients derived from the presence of the cadaver, as certain actual carnivorous plants have evolved to do, allowing it to thrive more than other saplings, but in this case it would not be through the plant itself pursuing a 'deliberately' carnivorous behaviour.

#2848: Breaker Box

October 30, 2023



Any electrician will warn you to first locate and flip the house's **CAUSALITY** circuit breaker before touching the **CIRCUIT BREAKERS** one.

Explanation

A distribution board, referred to as a "breaker box" here and also commonly referred to as a "fuse box", "breaker panel", "DB box", and many other names, is a metal box attached to a wall, usually in some maintenance area, containing multiple circuit breakers that distribute electricity to various parts of the building. A circuit breaker is an electrical switch, usually in the form of a small lever, which disconnects the circuit from the power source when opened. These breakers are designed to automatically open if too much electrical current flows through them. This is a safety measure to reduce the risk of damage and fire in the event of a short circuit or an overloaded line. These breakers can also be opened manually, deactivating the circuit to allow electrical work to be done.

In breaker boxes, each individual breaker is typically labeled to let the operator know what that breaker controls. Typically, the circuit controlled by each breaker will feed an intuitive set of connections: a certain room, or set of rooms, or possibly a set of related services (like overhead lights, or all the outlets on one floor). Some large appliances will have a dedicated circuit and breaker.

However, in houses that have been rewired multiple times (or were poorly wired the first time), this can quickly become overcomplicated with seemingly random connections. Randall lives in Boston where much of the housing stock is from the late 1800s and early 1900s, and

he is likely to live in a house with non-ideal wiring, which may have inspired this comic.

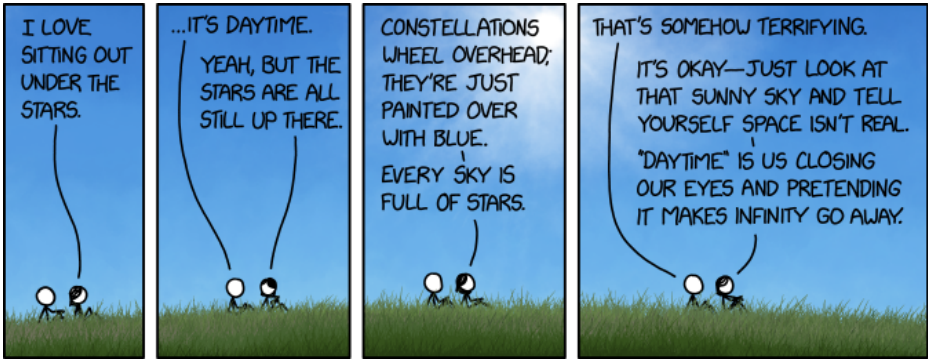
The comic satirizes these complex wiring setups, with multiple breakers "controlling" arbitrary things, including some that – in the classic style of xkcd – are puns on the word "breaker" or may be impossible to hook a breaker up to, getting progressively more absurd to the point of nullifying laws and "breaking" certain laws of physics.

Typically, switches in a breaker-box have the same orientation of "on" and "off" direction. This particular setup appears to adopt the convention that all switches are on (or, possibly, that all are off) when flipped towards the centre of the panel. Exactly which direction the switches are installed would be more obvious from coloration, markings or even relief details that would be manufactured into the switch subunits but which are not so fully depicted in the comic.

Table of the breaker labels[edit]

#2849: Under the Stars

November 01, 2023



If you live in Los Angeles (around $33^{\circ}52'N$, roughly the latitude of Hermosa Beach) the black hole in V404 Cygni passes over you each day. On Christmas Day it will be directly overhead around 2pm.

Explanation

The phrase "under the stars" generally refers to being under a visible field of stars — either real stars visible at night, or representations of stars constructed by people, as in a dance hall. Megan points out that we're always under the stars, they're just obscured ("painted over") during the day by the brightness of the Sun and its interaction with the sky. Of course, this makes the 'under the stars' part of the remark redundant in the first place, because by this definition, sitting outside is always under the stars. Also, since the Sun is itself a star, regardless of whether or not the other stars are visible when it's daytime, you would always be under at least one visible star. In fact, sitting inside is arguably under the stars as well, since the stars are still there, just obscured by a roof or other construction. Poetically, though, it could be taken to mean that Megan simply loves to sit and ponder the very existence, vastness, numerousness, etc. of the stars, even when she can't see them.

This is related to the concept of object permanence, which is the understanding that objects continue to exist even though we can't physically sense them. When you close your eyes, the universe doesn't go away even though you can't see it; similarly, when the Sun is shining, the stars are still all there.

In the early days of *xkcd*, it was common for Randall to publish a comic that was not intentionally funny — often also featuring Cueball and Megan — so this is a bit

of a return to form.

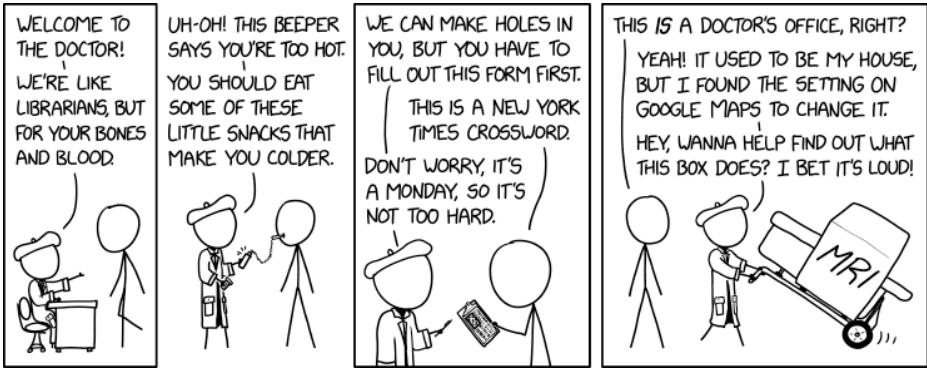
The title text mentions V404 Cygni, a binary system composed of a 9-solar-mass black hole and a star smaller than the Sun. With a declination of $+33^{\circ} 52' 02.0''$, once every 23 hours and 56 minutes (366.24 times per year, compared to 365.24 solar days within the same timeframe), it 'passes over' any point of the rotating Earth with that latitude north, like Los Angeles, Atlanta or Beirut.

The night sky being "terrifying" is probably related to a quote from Blaise Pascal:

This may also be a subtle reference to the short story *Nightfall* by Isaac Asimov and the related novel (also with Robert Silverberg). This story takes place on a planet that has so many suns that they never have darkness and can never see the stars. In that story an eclipse occurs every 2049 years which causes a complete psychological breakdown of everyone on the planet, as they all fear the dark and have no concept of the vastness of space nor of the existence of other stars. In this comic, the reference to a sky full of stars being "terrifying" is reminiscent of that short story and novel.

#2850: Doctor's Office

November 03, 2023



"The police told me I can't be a doctor, but whenever they show up I just go into the Google Maps settings page I found and change the house to 'Police Headquarters' and then they have to do what I say."

Explanation

In this comic, Beret Guy has discovered how to add public labels to locations on Google Maps. He has used the tool to label his house as a physician's office, and then proceeded to put on a white lab coat and impersonate a physician, making this another comic with one of his special businesses.

As Cueball arrives for a medical consultation, Beret Guy proceeds to do what he does best -- try to sound like a professional through absurdist, oddball dialogue:

In the third panel, Beret Guy then hands Cueball what's supposed to be a medical consent form, but is in fact a New York Times crossword puzzle for a Monday on a clipboard. Monday NYT crosswords are the easiest of the week; New York Times crosswords get more challenging over the week, with Saturday being hardest (Sunday's grid is larger, but has about the same difficulty as Thursday). Beret Guy amusingly misinterprets Cueball's hesitation as being about the difficulty of the crossword.

In the fourth panel, Cueball finally questions whether Beret Guy's claim is accurate, and the facts of the situation are revealed - while Beret Guy wheels in a device labeled "MRI" (for "magnetic resonance imaging"). He wonders aloud what the MRI is for and excitedly predicts that it is loud.

- Most MRI machines are huge and cannot be wheeled

in by one person on a dolly. They're typically housed within dedicated rooms and require specialized infrastructure to support their weight, shield their powerful magnetic fields, and maintain their functionality. So either:

this is just one piece of an MRI machine

it's mislabeled

it's a small MRI of the kind used to scan only one part of the body at a time, e.g. an ankle or knee; this is called a "bedside low-field MRI" and has a weak magnetic field

"MRI" stands for something else in this case.

Beret Guy is exercising one of his strange powers.

- And MRI machines are indeed very loud, known for producing banging sounds and other noises, often reaching up to 100 decibels, due to the rapid switching of their magnetic field gradients during scans. To protect their hearing and reduce discomfort, patients are typically provided with earplugs or headphones.

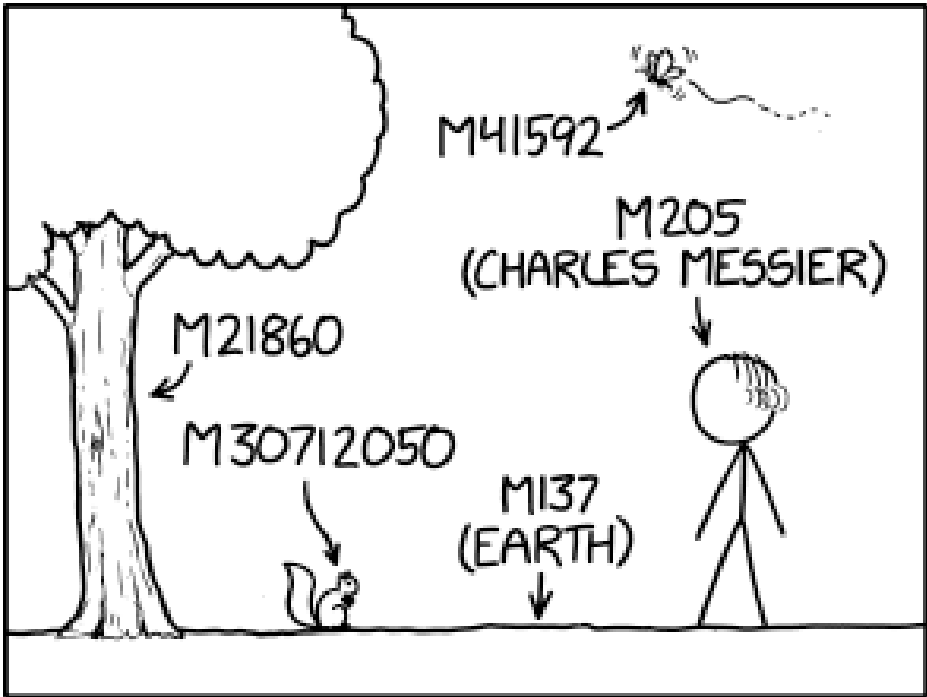
In the title text, Beret Guy acknowledges that the police repeatedly turn up to look into his 'clinic', but each time he heads off their investigations by returning to Google Maps and relabelling his house "Police Headquarters", thus (by implication) making himself Chief of Police to whose authority the officers must submit - which he may also believe removes evidence for any charges of "impersonating a physician". If this works as claimed, it's another of the strange powers of Beret Guy. But this strategy is unlikely to work in real life; a suggested Google

Maps edit can take several days to be approved by Google Maps editors (unless Beret Guy is hacking Google and directly editing their map database), and "Police Headquarters" is not a category selection open to everyday users.

A physician imposter was also featured in 699: Trimester, while possibly authentic physicians behaving badly appear in 938: T-Cells, 1471: Gut Fauna, and 1839: Doctor Visit.

#2851: Messier Objects

November 06, 2023



PEOPLE USUALLY FOCUS ON THE
FIRST 110, BUT THE MESSIER CATALOG
ACTUALLY INCLUDES *ALL* OBJECTS.

The debate over the correct Messier number for the Ship of Theseus is ongoing.

Explanation

This comic is a play on the Messier Catalog, which is a famous list of astronomical objects "that are not a comet" compiled by the French astronomer Charles Messier in the 18th century. The real Messier Catalog includes 110 objects, which are all deep-space objects like nebulae and galaxies.

In the comic, it's humorously suggested that the catalog includes not just these distant celestial objects, but also very ordinary things found here on Earth. Each ordinary object is labeled with an "M" followed by a number, just as the real Messier objects are numbered (like M1, M2, etc.). However, the numbers are much higher than the 110 included in the actual catalog, and they point to mundane things such as the Earth, Charles Messier himself, a tree, a butterfly and a squirrel.

The numbers increase as the objects go from large and significant to humans (the Earth, Charles Messier) to those that are smaller and less significant (a tree, a butterfly, and a squirrel). However, this pattern isn't strictly numerical (i.e., there's no clear mathematical sequence), but rather a conceptual one where the numbers arbitrarily become larger for things that are commonly considered less monumental or noteworthy than celestial objects.

So, the comic is a playful take on a piece of astronomical history, suggesting that everything in the universe is part

of the Messier Catalog, not just the deep sky objects Messier originally listed.

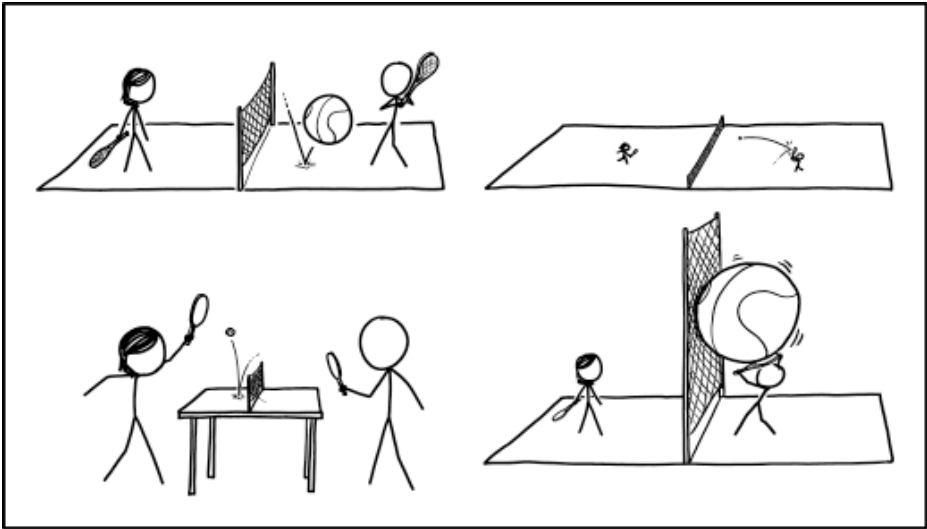
The title text refers to the Ship of Theseus. This is a popular thought experiment: if a ship is repaired and/or modified such that it has all of its parts replaced over the years, is it the same ship as the original? And then, what if you take all of the parts that were removed and create another ship using those parts? Are they both the same ship, and if not, which one is the original ship? The title text suggests that this leads to a debate as to whether the original ship and the new ship (with all of its parts replaced) should be considered the same object and therefore given the same Messier number, or the two ships should be considered different objects with different Messier numbers, and if so, which of them should retain the original number.

"M41592" may be a reference to pi as it contains 5 of the first digits at 3.141592. Also noteworthy is that (the real) M6 is called the Butterfly Cluster. However, there are no real galaxies in the original Messier Catalog named after trees or squirrels.

"M137" for Earth seems likely to be a reference to the animated sci-fi/comedy show Rick and Morty, since the version of Rick primarily followed by the show comes from Dimension C-137, even identifying himself as Rick C-137 when around Ricks and Mortys from other dimensions.

#2852: Parameterball

November 08, 2023



PARAMETERBALL IS A RAQUET GAME DIVIDED INTO
FOUR QUARTERS, WITH BALL SIZE, COURT SIZE,
AND NET HEIGHT RANDOMIZED EACH QUARTER.

The ball's density also varies, but players don't learn the value until after choosing their raquets. The infamous 'bowling ball table tennis' region of the parameter space often leads to equipment damage.

Explanation

This comic depicts the game of parameterball, a "raquet" game. This is a misspelling (creative or unintentional) of the sports equipment that is spelled "raquette" in French (probably from the Dutch for the action of "striking back"), was adopted into English as "racquet" and later acquired the alternative (and extremely common) form "racket" (etymologically distinct from the noise/"protection racket" use of that word).

There are a number of distinct racket sports, which generalise to various forms of opposing players hitting a projectile between their respective zones of control. These are usually two-sided (2-or-4 players) point-scoring games using a delineated court/playing-surface, with a net or markings defining either side's control of play. The projectile is often a ball of some kind (or equivalent, such as the shuttlecock), which must be hit with a racket(/'paddle' bat). Often, the objective of the game is to hit the ball so that it bounces on your opponent's side, in a legitimate manner, that cannot then be legitimately returned. Two notable examples of this kind of game are Tennis and Table Tennis (also known as Ping-Pong), which demonstrate the potentially different scales of playing area, ball and net.

In this comic, a game called "Parameterball" is proposed, where net size, ball size, and court size are randomized every quarter. There are 4 different instances of Megan and Cueball playing this game, each in one corner of the

comic, so we can assume all four of these were used within the same game of Parameterball. The different examples provide insight into the absurd games that may be played in Parameterball, depending on how mismatched the racket, court, and ball size are.

Such kind of parameterization is typical in designing video games. Typically, the main premise of the game is written in code with several parameters added to the logic to fine-tune the feel and balance of the game by trying different values. In this case, the main premise of the game is hitting a projectile back to the opponent, as noted above, while the parameters are the size and height of the court, ball, and net. The comic, in its extreme absurdity of parameter range and selection, illustrates the wide range of possible games by tuning a few parameters. Some video games similarly also provide alternate modes that provide a minor tweak in parameters to provide a different feeling game. Video game designers often talk about the arduous process of selecting the ideal parameters to tune the game exactly so the game is fun and challenging to play. Here, the aspect of playing random variations of the parameters itself is part of the game, rather than playing a finely-tuned set of parameters by someone else perfected for enjoyment.

The title text mentions that the ball's density is also randomized, and refers to instances where the net size, ball size, and court size were similar to that of a Ping-pong match, but with a ball as dense as a bowling ball, which not only led to equipment damage, but does so regularly. Despite this, the participants do not learn

the density until after their racket is chosen, meaning that they have no way of determining whether the racket they chose is durable enough until it's already too late. (Conversely, choosing an excessively robust item could be a bad decision when trying to play with a light ball, as it would be detrimental in reacting against rapid volleys by a more aptly-equipped opponent.)

The mention of this 'region in parameter space' refers to the theoretical 4-dimensional mapping of all combinations of values of individual variables: ball size, court size, net height, and ball density. The "bowling ball table tennis" region of that space refers to all games where the ball is about as dense as a bowling ball and the other parameters are similar to those of table tennis.

Note that the players can choose their own racket, and can do so after finding out the three parameters given in the main comic. Only the density of the ball is unknown when they choose the racket. Thus this indirectly leads to some randomness in the selection of racket also, as the players try to guess what would be best for a random choice of ball density.

It's unknown whether the parameters of Parameterball are unlimited or limited to what human players can reasonably work with, although the fourth phase of the game as demonstrated in the comic certainly seems to represent an extreme of both net height and ball size that appears to be causing problems. But if the comic shows the outliers then the table below lists the limits for the parameters.

Randall may have been inspired by Pickleball, a type of racket sport rising sharply in popularity in the US at the time this comic came out. Pickleball is a middle-ground of tennis and table tennis, with an intermediate-sized ball, court, and net height. Randall may have noticed the distinct parameters of pickleball's elements compared to its cousin sports and was inspired to imagine a scenario in which such parameters might be randomized.

This comic is reminiscent of 2663: Tetherball Configurations, also four different settings for the same sport, that makes it more or less playable. Randall also invented more unusual ball games with 1507: Metaball, 1920: Emoji Sports, and 2705: Spacetime Soccer

The parameters of the game being randomized is reminiscent of the "Calvinball" game in the Calvin & Hobbes cartoons, which is never played twice with the same rules.

Table of limits in the comic[edit]

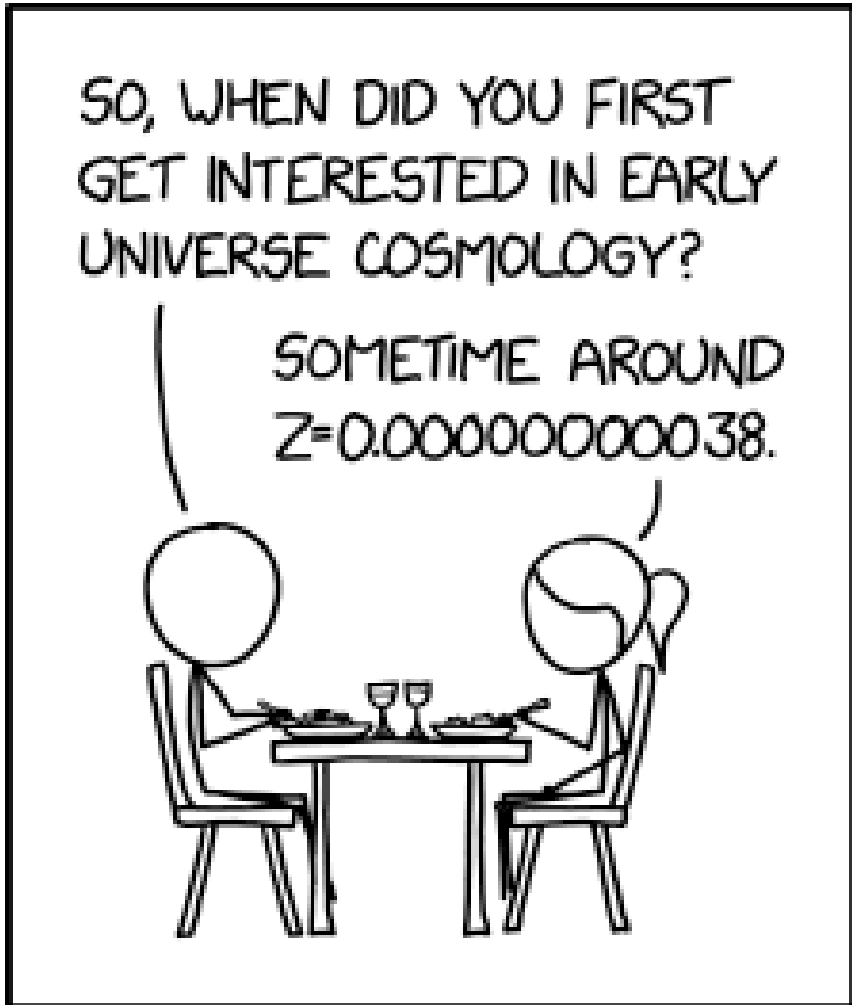
Assuming that the comic shows the full breadth of options, here are the approximate, apparent upper and lower limits of the four parameters mentioned:

It is unclear what rules, if any, there are about the size below which the court will be elevated on a table.

From what is shown, racket choice appears to be limited to those commonly in use in other existing racket sports.

#2853: Redshift

November 10, 2023



So do you have any plans for $z=-0.0000000000000045$?

Explanation

In this comic, Ponytail is using cosmological terms to answer that she first got interested in early universe cosmology 5.4 years ago, to which Cueball asks (in the title text) whether she has plans five and a half hours later. One interpretation is that these are two colleagues out for lunch, and Cueball likes her nerdy answer so much he wants to ask her out for a dinner date after work.

In observational cosmology, a field of astronomy, redshift refers to the way that light from distant objects in the universe is stretched out, making it appear more red than it would otherwise. This occurs because the universe is expanding, and as a result, light waves are stretched as they travel through space. The "z" value is a dimensionless measure of the redshift: the observed wavelength minus the expected wavelength, divided by the expected wavelength. A higher "z" value, or redshift, corresponds to earlier times in the history of the universe. This is because as the universe expands, light from distant galaxies is stretched to longer, redder wavelengths as it travels towards us. The further away a galaxy is, the longer its light has been traveling, and thus the more the universe has expanded since that light began its journey. Therefore, a higher redshift indicates a galaxy that is further away and that the light we see from it left when the universe was younger. Conversely, a lower redshift means the light has traveled a shorter distance and time, indicating a more recent epoch in the history of the

universe. Negative values of "z" indicate a blueshift, which indicate objects that are approaching the observer, generally used in cosmological work to calculate rotation speeds of closer objects.

The joke here is that Cueball is asking Ponytail when she became interested in cosmology, and instead of giving a conventionally referenced time (such as "in college", "as a kid", "in 2020" or "seventeen years ago", whatever may apply), she responds with a redshift value " $z=0.00000000038$ ". This very small number corresponds to a very recent event compared to the start of the universe; well within a human lifetime, though it might take a cosmologist's specific knowledge to understand this and work out the interval's value. The negative blueshift question in the title text is a playful way of similarly asking about a future event. As the absolute value of the negative z is about ten thousand times smaller, it indicates a much closer event in the future.

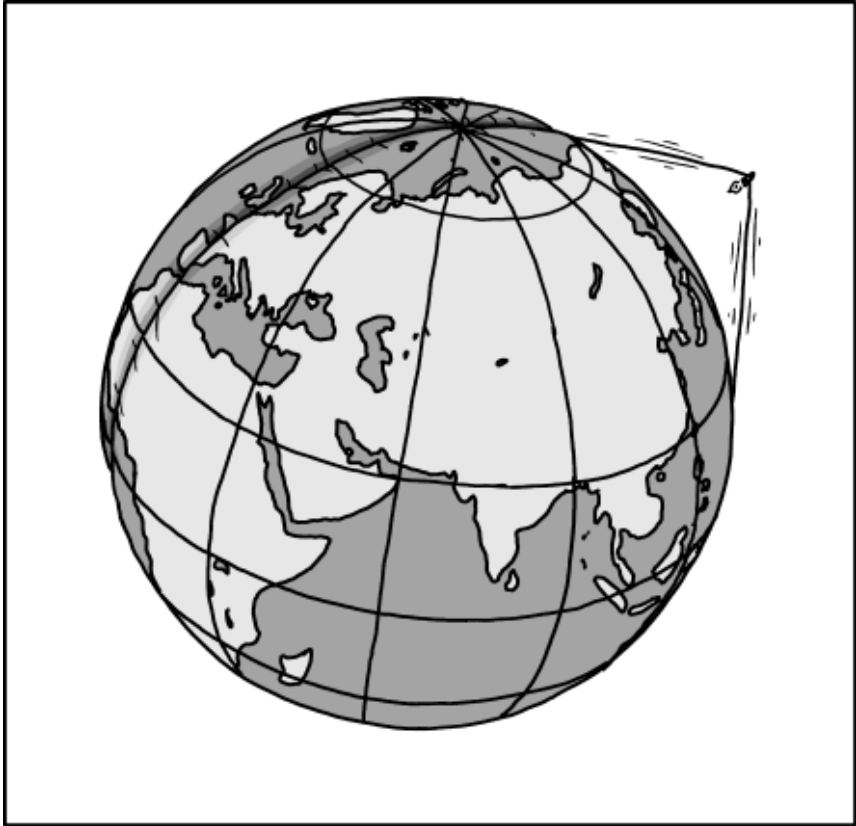
Assuming a given cosmology, its curvature, and a value for the Hubble parameter H_0 (also called the Hubble constant), it is possible to derive a specific look-back time for any given redshift value. For $z=0.00000000038$, a flat Lambda-CDM cosmological model with $H_0 = 69.32 \text{ km / Mpc / s}$ (a reasonable medium between the disparate "crisis in cosmology" values for the Hubble parameter), a value of Ω_0 of 0.2865, and a cosmic background temperature of 2.725 K, the look-back time is about 1960 days, or 5.4 years, which could suggest that Ponytail started studying cosmology as part of a Ph.D. program.

Negative numbers of z , such as in the title text, would indicate a "look-forward" time, or a time in the future, and the same model indicates that $z=-0.000000000000045$ corresponds to 5.5 hours in the future. So Cueball is likely asking something like "What are you thinking of doing (later) this evening?"

The use of non-standard units of measurement has also been seen in 2707: Astronomy Numbers, with much larger typical redshift values previously included in 2764: Cosmological Nostalgia Content. Redshift and blueshift have also been mentioned before in 1852: Election Map.

#2854: Date Line

November 13, 2023



TIMEKEEPING ANNOUNCEMENT: A ROCKET ACCIDENTALLY BECAME
SNAGGED ON THE INTERNATIONAL DATE LINE DURING LAUNCH.
PLEASE PAUSE ALL CLOCKS AND CALENDARS UNTIL NASA IS ABLE
TO FREE IT AND SAFELY RESUME THE NORMAL FLOW OF TIME.

They estimate the rocket should be free by
approximately ... uh ... well, in about two hours.

Explanation

The International Date Line is a nominal line on Earth near the antimeridian (180°) that represents where adjoining territories observe a full calendar day of difference (give or take the 'normal' time of day adjustment).

It causes one of three situations where the date might change for you, the usual one being when (in your time zone) you pass from the hour of 11 pm across beyond midnight, and a second being if you travel directly between time zones at such a time (usually that being a window of just one specific hour, at night) where they are each either side of midnight. Most people don't travel at or around midnight, and just being awake as the clocks tick over is not often such a remarkable thing, other than to perhaps mark reaching a special date (significant birthdays, perhaps, or New Year's Day). However, travel across or between certain areas of east and west Pacific (or vice-versa) is not so uncommon, yet brings with it the special need to effectively adjust your watch by a full day (plus or minus any other time to be adjusted).

The International Date Line is not a physical string,[citation needed] and therefore could not be caught by a rocket. It should also be noted that the International Date Line is not straight, but extends either side of the antimeridian to avoid confusion on internal land journeys (like Russia, a portion of which overlaps the antimeridian), similarly cutting off 'nearby' outlying

island territories or adding needless complexity when dealing with chosen trading partners. (There may also be the niche tourism-led motivation of being able to claim 'first' in experiencing the new date.) Of course, these very bends would give a physical International Date Line quite a bit of slack that a rocket could pull up (as depicted in the comic).

Based on what is shown in the comic, the rocket could have been launched by the Russians (e.g. from the Vostochny Cosmodrome), but the caption implies that the American space agency is the one expecting to resolve the issue (whoever's original error it was), and all orbital flights are pretty much guaranteed to cross (over) the dateline at some point in the initial track. Of course, the odds of a rocket getting stuck on such a line (if it existed) would be incredibly slim. Additionally, striking such an object wouldn't trap the rocket. Instead, the rocket (and likely the line) would undergo what many KSP users have encountered: Rapid Unplanned Disassembly.

The caption suggests that this event has messed up the normal regulation of time, and is somehow unsafe to 'use' as a result, so people should pause their usage of it by stopping their clocks and calendars. Also, because time is not behaving normally, 'they' can't give a time for when it will be fixed. If, say, it was 8:00 when the rocket got snagged, then it is 8:00 until they fix it. This means that no matter how much time should have passed, until they fix it, it will remain 8:00. In reality, even if a physical dateline did exist, and if disturbing it were to mess up our ability to measure time, synchronize clocks, and so on,

time itself would continue to flow regardless, and pausing one's clock would have no effect on this. Indeed, if time stopped operating, it's not entirely clear what an amount of time that 'should have passed' would even mean, or if we would be able to perceive that anything was wrong. Or, we could use more traditional ways of keeping the time that doesn't need the International Date Line, like water clocks or sundials until it's fixed.

More worryingly, yet oddly not mentioned by the announcement, is that the International Date Line and Greenwich Meridian appear to be a single continuous physical line, and consequently, the stretching of the former is pulling in the latter, causing significant geological disruption along that line, which would result in danger to life and property and infrastructure damage affecting many millions of people living close to it, and probably tsunamis that could threaten many more further afield.

The title text states that the estimated time the rocket should be free is "about two hours," but the speaker/writer hesitates when about to give an estimated time stamp, as the time does not advance on clocks, assuming the instructions are followed. Instead, a more generic time must be given, though there still remains the issue of how to properly judge the relative passing of time.

#2855: Empiricism

November 15, 2023



The problems started with my resolution next year to reject temporal causality.

Explanation

Cueball and Megan are discussing New Year's resolutions. Cueball says that his resolution for this year was to reject empiricism. Megan asks him how that worked out for him, to which Cueball gives a dismissive response.

Empiricism is the practice of testing a hypothesis based on direct observation and testing. The joke is that, since Cueball succeeded in rejecting empiricism this year, he doesn't care or think about how it went, since doing so would be empirical.

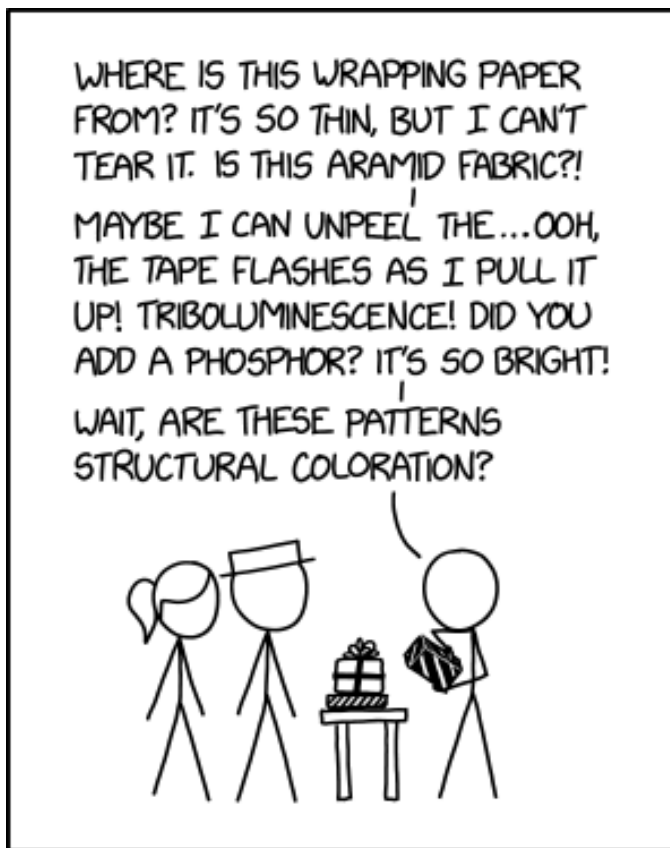
Technically speaking, Cueball's response can be more accurately characterized as a rejection of empiricism alternatives such as constructivism and pragmatism (the suggestion that knowledge is constructed by the individual through their interactions with the world, and the belief that value is determined by its success in practical application, respectively); if Megan had asked, "Did that work out for you as well as you had expected?" then Cueball's response would have been a more direct rejection of empiricism. As stated, this is just a technicality; Randall is probably using a layman's definition of empiricism-- something like "the theory that any and all knowledge comes from sensory experience."

In the title text, Cueball attributes past problems ("my problems started") to his future ("next year") resolution, which is to reject temporal causality. Temporal causality

is the principle in physics that the cause of an event always precedes the event. The joke is that his past/current problems are being caused by a future event, since his sense of causality is no longer time-based. This is Randall's second joke about causality in three weeks; a similar joke was published 7 comics prior to this one, in which a breaker box switch can turn off causality.

#2856: Materials Scientists

November 17, 2023



MATERIALS SCIENTISTS ARE LIKE CATS—
THE BEST PRESENT YOU CAN GET THEM IS
AN EMPTY BOX WITH COOL WRAPPING PAPER.

If a materials scientist gives you a present, always ask whether regifting will incur any requirements for Federal paperwork.

Explanation

Materials science is essentially the study of materials, like steel, including some pretty strange ones such as Vantablack and triiodide. Here Ponytail and White Hat have given Cueball (a materials scientist) some sort of present. Cueball is amazed with the wrapping paper and tape itself, trying to make out what they are all made of. The caption reveals that the cardboard box is empty and the wrapping paper is the present; as a materials scientist, Cueball is more enamored by the (strange and exotic) wrapping paper, far more than he would be by any actual present inside.

The punchline also compares Cueball to a cat. A common stereotype (with lots of image proof, to boot) about domestic housecats is how they enjoy playing with empty boxes and discarded wrapping paper much more than the cat toys contained therein.

Aramid fibers are a class of strong synthetic fibers, built from aromatic rings connected via amide linkages. Kevlar, a material commonly and perhaps most famously used as a bullet-resistant fabric for soft bulletproof vests, is an example of an aramid. Due to their strength, they can be quite durable, even when thin, as depicted in the comic.

Triboluminescence refers to a phenomenon where mechanically working on a material (in this case pulling on the tape) causes it to glow. Triboluminescence is still

not well understood by materials scientists, so they may find such materials particularly appealing. One famous example comes from crushing Wint-O-Green Lifesavers mints, which creates particularly bright blue sparks compared to other hard candies. Staying in the realm of wrapping, Scotch tape exhibits this property too, to a point where it can even be used as an x-ray. Phosphors, not to be confused with the element Phosphorus, are substances that glow when exposed to some other, typically more energetic, form of radiation, and can be used to produce a desired glowing effect by taking less useful parts of the spectrum (e.g. beyond the visible, or in an unnecessary area of the visible one) and shifting that into more practical hues.

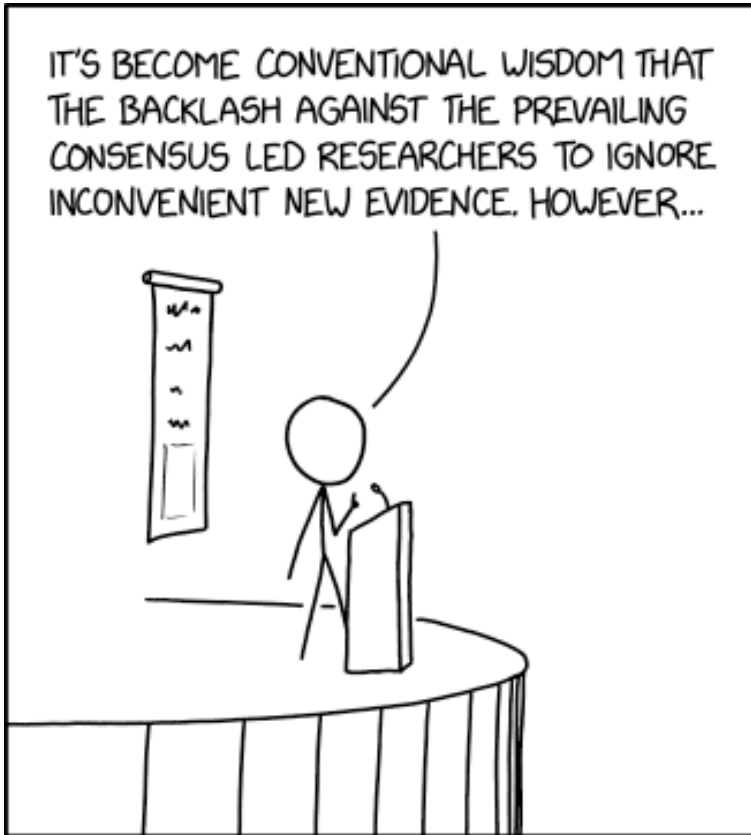
Structural coloration is a phenomenon where the coloration of an animal or plant is not produced via pigments but via structural interactions with visible light at the scale of a wavelength (e.g. diffraction gratings, thin-film interference). More generally, it can also be used to refer to artificial materials that have a similar effect.

The title text states that if a materials scientist gives you a gift, you should ask if regifting it requires any form of federal paperwork. This is because the materials scientist may have access to items which are dangerous and strictly regulated, such as polonium (an extremely radioactive element), fluoroantimonic acid (the strongest acid discovered), nitrogen triiodide (one of the most sensitive explosives in the world), and n-butyllithium (an extremely flammable, pyrophoric, and caustic

compound). Other examples include materials regulated for military reasons under ITAR, possibly up to being considered sensitive or top secret, such as high tech fibers, composites or other such materials with applications for armor (covered under e.g. CFR, Title 22, § 121, Category XIII (e)), or basically anything that has use in rockets (e.g. § 121 Category XIII (d)) or stealth (e.g. § 121 Category XIII (g) and (j)). All of those are at least export restricted, and require federal paperwork to be regifted or sold.

#2857: Rebuttals

November 20, 2023



IN A FIELD THAT'S BEEN AROUND FOR A WHILE, IT CAN BE HARD TO FIGURE OUT HOW MANY LEVELS OF REBUTTAL DEEP YOU ARE.

The mainstream dogma sparked a wave of dogmatic revisionism, and this revisionist mainstream dogmatism has now given way to a more rematic mainvisionist dogstream.

Explanation

This comic provides a satirical take on the intricate layers of scientific critique and consensus. Cueball stands as a representative of the scientific community, addressing the audience with a statement that encapsulates the recursive nature of scientific debate. The comic touches on the propensity within the scientific fields to oscillate between embracing new evidence and adhering to established consensus. It reflects on the inclination to reject new findings not because they lack merit, but because they conflict with the prevailing theories that have weathered previous scrutiny and dissent. Here is what Cueball is saying, simplified:

Overall, the comic offers a funny yet deep look at how scientists think and argue. It shows that in science, people often change their minds between new discoveries and what most people already believe. The character Cueball represents scientists and explains this complicated process. The comic starts by showing how scientists sometimes don't like new ideas if they don't fit with what most people already think. This happens even if the new ideas might be true. It shows a kind of tug-of-war in science: sometimes scientists are more open to new things, and other times they stick to old ideas. Also, the comic says that when people don't agree with the usual thinking, they might also ignore new facts that don't match their own ideas. Everyone in science might miss something important because they're too focused on their own beliefs.

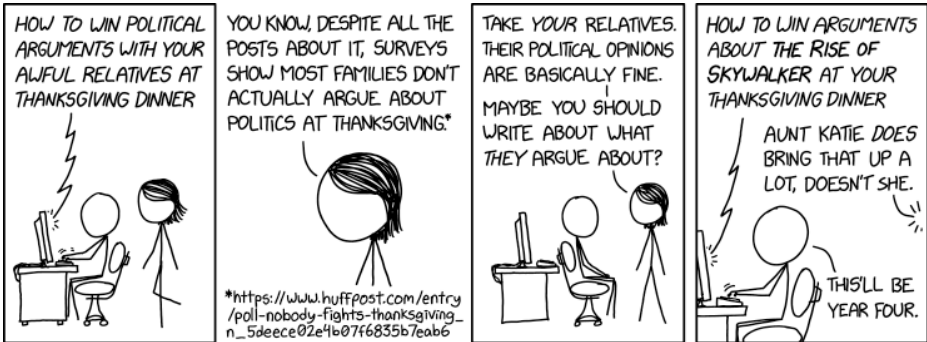
Cueball's words in the comic are like peeling an onion in science, showing different layers of arguments and disagreements. The comic suggests that sometimes, even when scientists are trying to move away from old ideas, they might not notice new facts that actually support these old ideas. Cueball seems to agree with this view but then starts to say "however," like he's going to give a rebuttal opinion or explain the situation in a new way. Maybe Cueball will offer a new explanation about how scientists argue or say that all sides in science have good points but sometimes misunderstand each other. This could mean that the debates in science are not as simple as they seem and that everyone might have a piece of the truth.

The title text serves as an extension of this theme, offering a linguistic maze that mirrors the complexity and sometimes absurdity of academic discourse. It whimsically encapsulates how a challenge to mainstream thought can solidify into its own dogma, necessitating further revisionist waves, in an endless cycle of intellectual evolution and revolution. This self-referential loop wittily underscores Thomas Kuhn's notion of the 'Structure of Scientific Revolutions,' suggesting that what is considered revolutionary at one time may become the very dogma that future revolutions seek to overturn. The title text delights in linguistic acrobatics, stringing together a series of portmanteau and near-repetitive phrases that dance on the tongue with the finesse of a verbal gymnast. "Mainstream dogma" suggests widely accepted beliefs, but it swiftly mutates

into "dogmatic revisionism," a playful jab at the stubborn insistence on reforming the norm. This revisionism doesn't just adjust the current; it becomes "mainstream dogmatism" in its own right, a new orthodoxy birthed from the rebellion. And then, with a flourish, it yields to an even more whimsically coined "rematic mainvisionist dogstream," a hilarious spoonerism that could leave even the most loquacious academic's head spinning. This nonsensical cascade mocks the sometimes pretentious and convoluted language that can plague scholarly communication, turning serious dialogue into a merry-go-round of terms that are as circular in progression as they are in logic. This nonsense sentence may also be mocking the way in which, when you get this many layers deep in waves of consensus and counter-consensus, all these terms start to lose any real meaning, and become mere empty labels to be thrown around as terms of deprecation or abuse between the competing factions.

#2858: Thanksgiving Arguments

November 22, 2023



An occasional source of mild Thanksgiving tension in my family is that my mother is a die-hard fan of *The Core* (2003), and various family members sometimes have differing levels of enthusiasm for her annual tradition of watching it.

Explanation

The comic features a conversation between Cueball (possibly representing Randall) and Megan, discussing the dynamics of family gatherings during Thanksgiving, specifically about the topics of political arguments and how to navigate them. This was a topical comic, as Thanksgiving in the United States in 2023 was on November 23, the day after the posting of this comic.

In the first panel, Cueball is depicted sitting at a computer, presumably writing an article or blog post titled "How to Win Political Arguments with Your Awful Relatives at Thanksgiving Dinner" - a common topic for 'filler' articles at this time of year. Such articles are based on the perception that political arguments are common at holiday dinners. This is likely based on the idea that people will tend to avoid relatives with "awful" political views, but holiday dinners carry the expectation that the whole family will be together, making such arguments difficult to avoid.

Megan challenges this perception, citing an article in Huffington Post which reports on a poll which found that only 16% of families reported discussing politics at Thanksgiving dinner, and only 3% reporting having argued about politics. She also points out that Cueball's family has political views that are "mostly fine". This is probably not especially uncommon, as families tend to share similar experiences and backgrounds, which inform their political opinions. Where disagreements do occur,

it's common for those to be minor, and not the subject of particularly emotional arguments. In addition, where politics are a source of friction within a family, most learn not to bring it up at holiday gatherings, precisely to avoid such arguments.

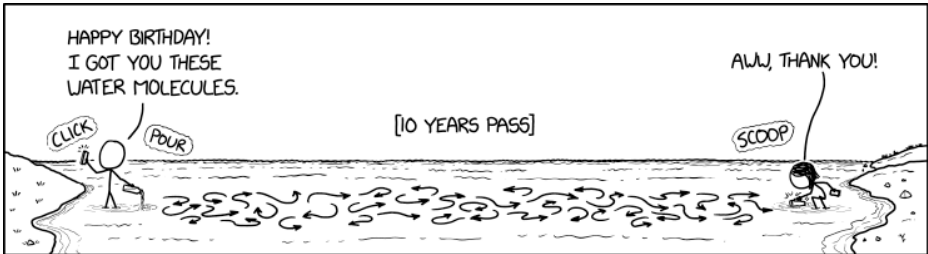
The misperception at the root of this may be a case of selection bias. There certainly are families in which members hold opposing political views[citation needed] with such emotional fervor that gatherings typically devolve into arguments. Since those arguments can be so intense and emotional (and often personally hurtful), the people involved are far more likely to relate their experiences to others, both in person and in media (such as in articles, columns, and portrayal in fiction). By contrast, people who have quiet, undramatic family dinners are less likely to get attention. This can give rise to the perception that heated political arguments are the norm for such gatherings.

The comic concludes by revealing that Cueball's family, rather than arguing about politics, tends to argue about *The Rise of Skywalker*, a controversial recent entry in the Star Wars franchise, with Megan agreeing that his aunt "brings that up a lot". The joke is that Cueball's family, like him, tend to have nerdy, pop-culture-based passions, and those are areas that are far more likely to result in family debates. The title text extends this theme by referencing the mother's devotion to the 2003 movie *The Core* (widely considered a contender for "all-time-worst 'science in a movie' winner") and her insistence on watching it annually during Thanksgiving is mentioned

as a bone of contention within the family. This underscores the idea that perceptions of a "normal" family gathering (ie, arguing about politics) aren't necessarily applicable to most families. The individual character and eccentricities of each family are far more likely to define what their holidays are like.

#2859: Oceanography Gift

November 24, 2023



GLOBAL SURFACE OCEAN CONNECTIVITY TIMES ARE ≤ 10 YEARS (JÖNSSON & WATSON, 2016, DOI:10.1038/ncomms11239), SO IF YOU'RE WILLING TO PLAN AHEAD, YOU CAN POUR WATER INTO THE OCEAN WHILE WISHING SOMEONE A HAPPY BIRTHDAY, AND THEN IN 10 YEARS LET THEM KNOW THEY CAN PICK UP THEIR GIFT AT THE NEAREST COASTLINE.

Shipping times vary. Same-ocean delivery may only take a few years, but delivery from the Weddell Sea in Antarctica may take multiple decades, and molecules meant for inland seas like the Mediterranean may be returned as undeliverable by surface currents.

Explanation

In this comic, Randall seems inspired by the timing of ocean currents, much as he has previously been with air currents, although he may even have already considered some of the technicalities prior to that. As supporting evidence, he provides a DOI reference to a 2016 Jönsson & Watson open-access article in *Nature Communications*, 'The timescales of global surface-ocean connectivity'. This would be extremely impractical, since in ten years, it's possible that you and the recipient broke connections, or one of you (or both of you) passed away. If these scenarios are not the case, ten years is an awfully long time to wait for a present.

In this specific (fictional) example, the water dumped into the ocean today will take ten years to circulate round to the depicted neighbouring coastline (wherever that is). Which implies significant planning ahead is necessary before posting water to someone. And a lot of presumption about the lack of any other dispersal/dilution, or that some degree of fungibility is acceptable, so long as it is philosophically the same group of molecules involved. Of course, some of the water molecules may take a short-cut by being evaporated then precipitated closer to the delivery site.

The title text mentions that "same-ocean delivery" may only take a few years, as the coast lines are in the same general body of circulating water, and doesn't have to pass around large obstacles (like continents) or through

small gaps (straits). But if you wish delivery from Weddell Sea it may take decades. The Weddell sea lies near the Antarctic Peninsula, part of the Southern Ocean whose circulation can be considered largely isolated from the neighbouring bodies of water by the Antarctic Circumpolar Current. In particular, that area contains the Weddell Gyre one of the two ocean gyres in that area.

The title text also mentions inland seas, which can be generalised as bodies of water that are very large in area but either completely surrounded by dry land or connected to an ocean only by a river or a strait. He mentions the Mediterranean Sea which is only connected to the Atlantic Ocean through the narrow Strait of Gibraltar; the intention of the title text is to suggest that water molecules dumped in an ocean would not get to appear in such a sea (except by evaporation and reprecipitation) into its catchment area) and thus they can only ever circulate back to the dumping point (deemed 'undeliverable').

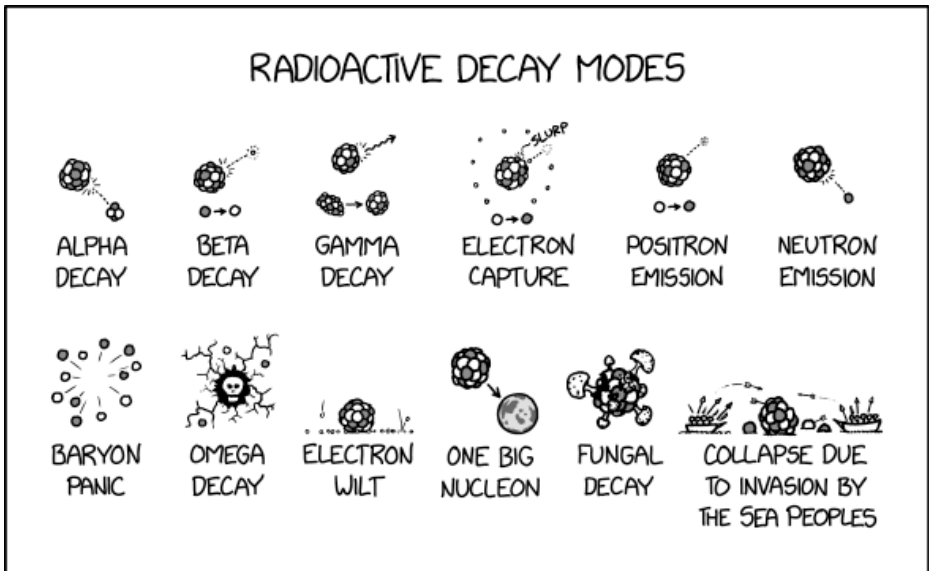
In reality, the Mediterranean Sea is not completely cut off from the main oceans and surface currents actually do reach into and around the Mediterranean. The natural loss from evaporation is not fully compensated for by the inflow of the incident rivers from southern Europe, North Africa and Asia, directly or via other attached bodies of water (e.g. the Black Sea). The movement of water also involves the deeper Levantine Intermediate Waters layer (a subsurface current) which exits via Gibraltar and helps to further draw current inwards at the surface level. As such, except for a limited

amount of water which reverses direction within the extreme western end the Mediterranean, it is more true to say that surface currents cannot actually transport water from within the sea outwards into the Atlantic (and beyond). (This explanation ignores flow through the Suez Canal.)

The Caspian Sea is a real inland sea that has no outlet to any oceans and only inlets from rivers, one of a number of endorheic basins that are also lakes, and thus trivially isolated from all other maritime currents.

#2860: Decay Modes

November 27, 2023



Unlike an Iron Age collapse, a Bronze Age collapse releases energy, since copper and tin are past the iron peak on the curve of binding energy.

Explanation

Decay modes refer to the different ways in which unstable atomic nuclei transform into more stable ones, typically by emitting particles or radiation. The process of decay is a natural phenomenon that occurs in radioactive substances. There are several types of decay mode each characterized by the particles emitted or the energy released during the process.

In the comic's diagram, protons are white and neutrons are gray.

The first six modes are real, and most occur relatively frequently:

In alpha decay, an unstable nucleus emits an alpha particle, composed of two protons and two neutrons. Alpha decay is the primary source of helium on Earth, as alpha particles are ${}^4\text{He}$ nuclei. This decay mode is most commonly seen in proton-rich / neutron-deficient heavy nuclei, which normally have many more neutrons than protons. By reducing the numbers of protons and neutrons by 2 apiece, the product nucleus has a higher ratio of neutrons to protons.

In beta decay (more properly beta-minus decay), a neutron-rich nucleus emits a W^- boson, converting one neutron into a proton, as shown in the supplementary diagram. The boson, in turn, decays into an electron (the titular beta (minus) particle) and an electron antineutrino. The main diagram shows only the release

of the beta particle, which was the only thing expelled from the nucleus that could be observed directly when the types of nuclear decay were first described and enumerated.

In gamma decay, an unstable nucleus (represented by the lumpy, prolate nucleus in the diagram – representing a high-energy nuclear isomer) emits a high-energy photon known as a gamma ray and settles into a stabler, lower-energy state.

In electron capture, a proton-rich atom captures an electron from the K or L electron shell. This converts a proton into a neutron and emits an electron neutrino. Randall adds a 'slurp' written sound effect in the comic to make the effect more clear; in real life no sound is actually present in an electron capture event. [citation needed]

In positron emission, or beta plus decay, a proton-rich nucleus emits a W^+ boson, converting one proton into a neutron. The boson, in turn, decays into a positron (the beta plus particle) and an electron neutrino. Again, the main diagram shows only the beta particle, presumably for simplicity, the nucleon conversion being shown separately. This is much rarer than beta minus decay.

In neutron emission, a neutron-rich/proton-deficient unstable nucleus emits a neutron (which then goes on to decay into further daughter particles).

The other six modes are fictional:

Baryon panic: In this mode, all the subatomic particles flee the atom simultaneously, similar to a crowd fleeing a building during a fire alarm, or other similar states of panic in people. In reality, this mode of decay would require an incredible amount of energy. The like charges of protons do repel each other, but they are held together more tightly by the residual nuclear force in the presence of neutrons.

Omega decay: The atom has decayed and left behind a skull in its wake, leaving cracks in the area surrounding it and sending neutrons and protons flying everywhere. Whereas alpha, beta and gamma are the first three letters of the Greek alphabet, omega is the last, so the name omega might suggest the ultimate, final decay. The skull presumably represents the finality of such a decay given that the end stage of human decay leaves behind a skeleton, something that does not exist in nucleons.[citation needed] Many works of science fiction propose forms of radiation and/or particles with further letters in the Greek alphabet, such as The Omega Directive in Star Trek. In real life, the omega baryon was predicted to exist by Murray Gell-Mann's early quark theory, and then discovered several years later with the properties he had predicted. This mode may also represent the atom becoming the origin of a false vacuum decay, a theoretical decay of space itself, which would indeed spread outward and be very final and lethal.

Electron wilt: The electrons surrounding the atom fall to the ground. Some plants are subject to diseases that cause this kind of wilting of their leaves. Electrons will attempt

to settle into a 'ground state' but this does not involve them literally slumping to the ground, rather they will be as close as possible to the nucleus subject to the limitations of energy levels and the Pauli exclusion principle. In addition, since the ground is made of atoms, there would be no flat surface for the electrons to fall onto.

One Big Nucleon: The protons and neutrons combine to form a single huge baryon. Exotic baryons with more than the usual three quarks, such as pentaquarks, have been created in the lab but are not known to exist in nature. String theorists propose that black holes are actually fuzzballs, single "subatomic" particles which are macroscopic in size (namely that of their event horizon) formed by the fusion of the strings of in-falling matter under extreme gravitational conditions. This is also a joking reference to the concept of One Big Union, a goal promoted by some trade unionists since the late 19th and early 20th centuries, according to which all individual and national trade unions should gradually amalgamate into one single economy-wide trade union — the notional One Big Union — in order to organise and fight for workers across all industries and professions, rather than only within each union's specifically organised job sites. Prominent early proponents of the idea include the Industrial Workers of the World and Canada's One Big Union. The joke is that this is a kind of radioactive decay caused by revolutionary class consciousness shared between nucleons in different atoms.

Fungal decay: The nucleus rots, and fungal fruiting

bodies (toadstools and mushrooms) grow around it. This plays on the meaning of "decay".

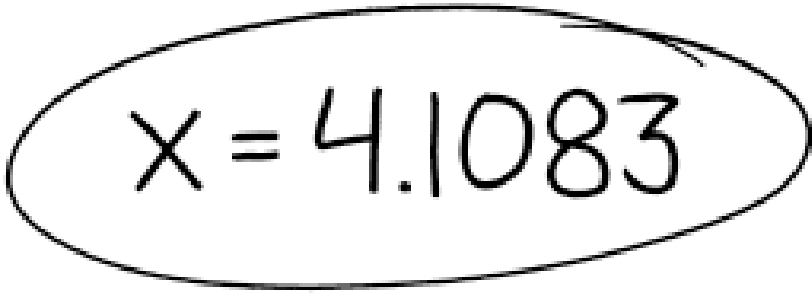
Collapse due to invasion by the Sea Peoples: The atom floats in water, with boats on either side full of Cueballs shooting arrows at it, and the atom is breaking up. The Sea Peoples are a somewhat mysterious group that attacked Egypt and other regions of the eastern Mediterranean in the late Bronze Age (1200-900 BCE). Due to a combination of factors, such as climate change, mass migration and invasions (including from the Sea Peoples), several nations around the central and eastern Mediterranean underwent societal decline or outright collapse, an occurrence known as the Late Bronze Age collapse. Randall has mentioned the Sea Peoples previously in 1732: Earth Temperature Timeline.

Bronze/Iron Age Collapse (Title text): Continuing from the last panel of the comic, and making a pun on the Iron Age of civilization with the properties of iron atoms. Nuclear fusion – the merging of small light elements – expels energy, powering stars and creating increasingly heavier elements which also fuse until the process reaches iron, predominantly ^{56}Fe . Fusing iron nuclei does not release energy, so the previous cycle of fusion abruptly stops and the star contracts under gravity (whereupon it can now create the different conditions from which small amounts of heavier nuclei do form, and disperse to be discovered in later star systems). In contrast, nuclear fission – where atoms spontaneously split into lighter elements, releasing the energy ultimately imbued into them during their synthesis – applies increasingly so to

the heavier nuclei with increasing instabilities as they 'collapse' out into their various fission products. The atomic components of bronze, tin and copper, could potentially release energy, in the right conditions. Tin's main isotopes (^{114}Sn across to ^{124}Sn , with more than two-thirds weight 116, 118 or 120) are considered stable, as are the two for copper (^{63}Cu and ^{65}Cu , being practically all that is naturally present), but trace/synthesized isotopes beyond that range (e.g., actively induced by initiating a neutron bombardment) are known to, eventually, beta(\pm) decay/'collapse' to forms of antimony (from the tin) or nickel/zinc (from the copper).

#2861: X Value

November 29, 2023


$$X = 4.1083$$

BIG MATH NEWS: THEY FINALLY
FIGURED OUT THE VALUE OF X.

The value of n is still unknown, but new results constrain it to fall between 8 and 10^{500} , ruling out popular ' $n=1$ ' and ' $n=2$ ' theories.

Explanation

In algebra, a variable is any symbol used to represent a number that has not been determined or chosen. The most familiar algebraic variable is x (the unknown input), with y often being the yet-to-be-determined output (its value being dependent on x). According to the comic, the value of x has finally been found, being 4.1083. The joke is that a general-purpose variable, which may take different values in different scenarios, turns out to have a specific value, as though it were a constant. Constants in mathematics and other scientific fields are also often represented by a single symbol - some of the most well-known are π (3.14159...), e (Euler's number, 2.71828...), i (an Imaginary unit, where $i^2 = -1$), and c (the speed of light in a vacuum, 299,792,458 m/s (670,616,629 mph, 1,079,252,848.8 km/h, 1.8026×10^{12} fur/ftn)).

The specific number 4.1083 does not have any notable significance or special role in the contexts of physics, chemistry, finance, astronomy or cryptography. This number to 3 decimal places, 4.108, was referenced previously in comic 899: Number Line.

The title text declares the value of n is unknown. n is often used as an unknown/undetermined integer value. In statistics, it might be used to specify the size of a sample. For example, a list where $n = 50$ would mean the list contains 50 data points, for which that number of iterations or a larger number of cross-comparisons might

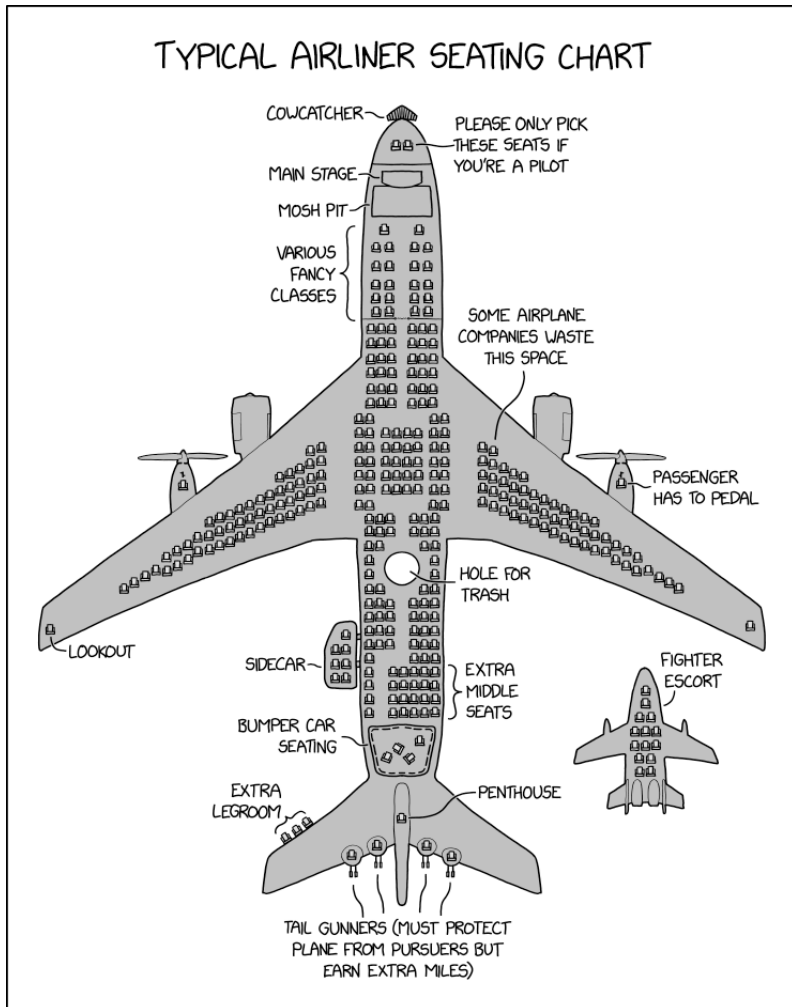
be expected.

According to the title text, however, the value of n has been narrowed down to somewhere between 8 and 10500, or one hundred quinsexagintacentillion. This narrowing-down isn't particularly narrow, although it is perhaps quite specific compared to the 'pre-narrowing' possibilities of being absolutely any finite value at all.

The title text also says that this narrowing has ruled out the (usually) simplest values of 1 or 2. In mathematical problems involving iterating over multiple inputs of a function, or functions where the input is a list of variable size, the variable n is used to represent either the current iteration's input or the length of the input list. In both cases the inputs " $n=1$ " and " $n=2$ " are used as examples to demonstrate the function, to let the reader wrap their head around the basics of the function. The title text is spoofing the usage of " $n=1$ " and " $n=2$ " as if they were the leading theories for the constant value of n , and that these theories have been debunked by supposedly proving that n 's minimum value is 8.

#2862: Typical Seating Chart

December 01, 2023



Now that airlines have started adding wheel locks to their drink carts, less than half of flights have one accidentally fall out through the hole.

Explanation

This comic shows a seating chart for a 182-seat airplane (and its fighter escort) with several unusual features.

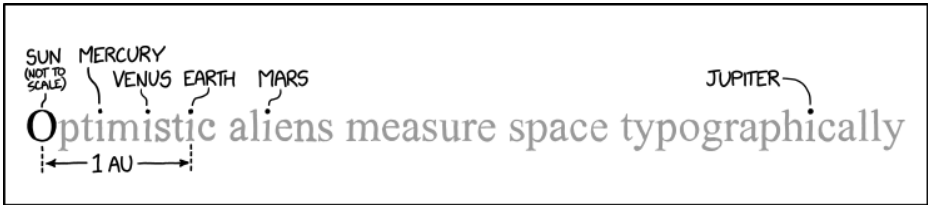
The total of 182 seats on the plane is a similar amount to a typically equipped Boeing 737-800, a very popular passenger plane. Up to 7,000 are in use around the world for short-range and mid-range flights. A typical Boeing 737-800 with 189 seats has a one-class layout in the configuration of two blocks (left and right) with each row of each block having three seats (left/middle/right). A bit simpler than what's seen here.

The presence of lookouts, tail gunners and a fighter escort suggests that this plane expects to be a target of air-to-air attacks, which suggests it may be carrying VIPs and flying over uncontrolled airspace with the possibility of attack.

The title text expands on the hole, suggesting that it was a common occurrence for drink carts to fall down the hole until they implemented wheel locks. The lack of wheel locks would make it easier for a cart to slide towards the hole.

#2863: Space Typography

December 04, 2023



SPACE TIP: IF YOU'RE EVER LOST IN THE INNER SOLAR SYSTEM, YOU CAN JUST TYPE OUT THE PHRASE "OPTIMISTIC ALIENS MEASURE SPACE TYPOGRAPHICALLY" IN TIMES NEW ROMAN AND USE THE DOTS AS A MAP.

And over heeee[...].eeeee (i)s Saturn.

Explanation

This is another one of Randall's Tips, this time a space tip, the first of two in a row, the second being 2864: Compact Graphs with a design tip.

Randall has created a sentence with the property wherein, when printed in Times New Roman font, the distances of the "i" letters from the first letter are proportional to the radii of the orbits of the innermost five planets in the Solar System. These are the only letters in the sentence that have a dot over the letter (there are no "j"s in the sentence) or elsewhere (there are no periods, colons, semicolons, or other dot-containing symbols). He suggests that if you get lost traveling among these planets, you can use the dots as a map.

This won't actually be a very useful map. When traveling between planets, it's not enough to know where the planet's orbit is, you also need to know where it is along the orbit. Additionally, if you are truly lost then you likely do not know where you actually are, and which 'way' you are heading, though you can probably at least locate the sun if you are indeed within our inner solar system.

The sentence is self-referential, since it talks about using typography to measure distances in space, and this makes it a useful mnemonic. The "optimistic" in the sentence could indicate that the aliens in question are highly optimistic that this kind of "map" would be useful for

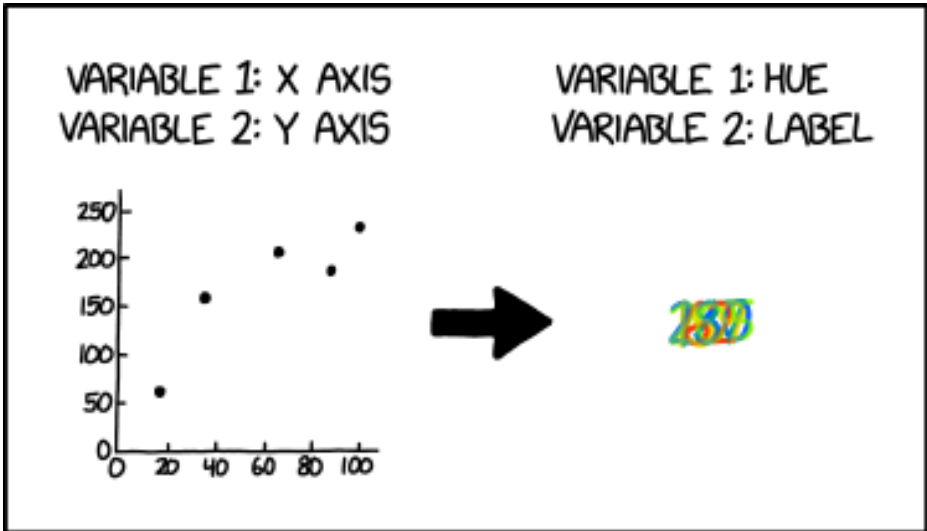
navigating a star system where planets orbit in ellipses, rather than being in static positions along a line (as is so often depicted in line-ups of the Solar System's planets).

The title text appends the sentence with a section for identifying Saturn. It contains an ellipsis in brackets, which normally signifies that an indeterminate number of 'e's has been omitted from the sentence, seemingly to represent Saturn's large orbital radius as the next "i" in "is". The trick is that actually appending the sentence literally, brackets and all, after the original sentence (so that we get "Optimistic aliens measure space typographically. And over heeee[...]jeeere (i)s Saturn.") actually puts the dot on the last "i" at Saturn's orbit. The extra dots and periods beside the six 'i's only serve as punctuation and spacing; the parentheses, besides spacing, call attention to the 'i' in the title text, where the black emphasis of the comic is not available. They're also reminiscent of Saturn's rings, although they are much too large and off-center.

Similar sentences with varying numbers of "e"s could be used to continue out to any planet or other body which does not contain the letter "i" – which is all of the remaining planets and minor planets, with the exception of Eris. However, the strings of "e"s would get longer and longer, to the point that it might be necessary to write down how many of them are to be used – about 59 "e"s for Saturn, starting from the Sun – which negates any mnemonic value the sentence may have had and might as well just be replaced with a table of orbital ephemerides.

#2864: Compact Graphs

December 06, 2023



DESIGN TIP: YOU CAN MAKE YOUR GRAPHS MORE SPACE-EFFICIENT BY USING HUE AND LABEL FOR THE FIRST TWO VARIABLES, INSTEAD OF ONLY TURNING TO THEM ONCE YOU'VE USED UP THE X AND Y AXES.

People may complain about readability, but even with jpeg compression, extracting the data points is usually computationally feasible if there aren't too many of them.

Explanation

This is another one of Randall's Tips, this time a design tip, the second of two in a row, the first being 2863: Space Typography with a space tip. The comic is unusual because Randall makes an apparent error (see below).

Randall tells graphic designers they can be more space-efficient by using hue (an element of color) and the data point's label in their graphs to represent the first two quantitative dimensions of a dataset rather than what's traditional: using x and y axes and then using hue and label to represent additional dimensions (such as hue for the z-axis, or the label for qualitative info).

In this comic's hue-label graph, the x-axis dimension is (mostly) translated into corresponding hue values, and the y-axis dimension is translated into text labels; that is, the mass of colorful lines in the comic is actually several numbers written in the same spot. Each number is one of the y-coordinates of a point in the left graph, and its color (usually) corresponds to its x-coordinate using the Hue, Saturation, Value (HSV) model. In other words, the labels' colors are not arbitrary; each color represents a numerical dimension of the data point as a Hue value from 0 to some maximum. Typically this is up to 360° in the wraparound continuum of the HSV or HSL color models, where Red is zero/360, but other numeric relations and subsets can be chosen to avoid unnecessarily confusing the lowest-value hues from the highest (of a non-cyclic scale) and/or to align more

meaningful colours (e.g. blue for cool and red for hot, avoiding the magenta segment as much as practical from either direction).

In the HSV color model, the hue component represents the color type and is expressed as an angle on the color wheel, where 0 degrees is red. The hue values are given in degrees, ranging from 0 to 360. Each value corresponds to a position on the color wheel, defining a specific color. An obvious limitation of this approach is that when used like this to represent specific quantities, the Hue dimension can only handle values from 0 to 360, and values within a narrow range (e.g., height of a basketball team's players as measured in inches) would all appear to be similar shades of a single color (e.g., yellow-ish green).

This Hue-Label graph contains the five data points as an orangish-red 62, a yellow 159, a green 205, a turquoise 187 and a blue 230.

Interestingly, the first three data points have hue colors representing their x-axis values, while the last two data points' colors correspond to their y-axis values. Mixing up x and y values for these last two is an apparent error. All 5 should have colors representing x-axis value, and y-axis values should be used only for the data labels. If this were a math assignment, Randall would earn partial credit.

This inconsistency may be an accidental mistake on Randall's part, or it may be intentional.

Randall's intent may have been to both (1) keep the x-axis values of his illustration between 0 and 100 (perhaps they represent real-world percentages) while (2) having a range of colors across the rainbow for the Hue-Label graph. But if a full color range was his motivation for the mixup, it's not clear why he didn't simply make the dataset's x-values range from 0 to 360 to cover the full range of potential hue values. Either way, the inconsistency satirically reinforces how limited this type of graph style actually is; a "hue-label" graph is so unhelpful that even the author (perhaps) didn't notice he was graphing his values incorrectly.

An hypothetical example of a potential topic for these 5 datapoints is Exercise Duration vs. Calorie Burn. In this scenario, on the x-axis, the duration of exercise in minutes (0 to 100) would be plotted, and the y-axis would show the calories burned (0 to 250). The longer the exercise duration, the more calories are burned, but the graph shows it's not a perfect correlation. Many other scenarios are possible.

The title text mentions that people may complain about readability, as is evident from the jumbled mess of seemingly meaningless lines in the hue and label graph in the comic. It says that discerning the data points is "computationally feasible, as long as there aren't too many of them". The decryption of information being labelled as "computationally feasible" implies that it is so difficult to discern, that the best thing that can be said about it is that it is not completely impossible.

A color scale graph was previously the source of a joke in 2537: Painbow Award.

Additionally, hue is commonly used to represent a proportional dimension in geospatial analytics, such as relative rainfall on meteorological maps or relative height on topographical maps (hypsometric tints), usually with a key. This is quite different than using hue to directly represent a numerical value from 0 to 360.

#2865: The Wrong Stuff

December 08, 2023



THE SPRUCE GOOSE, THE PROJECT HABAKKUK ICE SHIP, AND THE TROJAN HORSE WERE ALL THE WORK OF THE MATERIAL PHANTOM, A GHOST THAT WANDERS THE EARTH CONVINCING ENGINEERS TO MAKE GIANT VEHICLES OUT OF THE WRONG STUFF.

The phantom found Edward Everett Hale a century too early; by the time we invented satellites, the specifics of his 'brick moon' proposal were dismissed as science fiction.

Explanation

Multiple times in history, there have been incidents where companies, governments, and engineers have proposed or developed plans for large vehicles composed of unconventional materials. One example is Project Habakkuk (mentioned in the comic), an aircraft carrier which was to be composed of pykrete, a mixture of wood pulp and ice. The comic imagines that all of these proposals are linked together by a single "Material Phantom," a ghost which haunts engineers and convinces them to design giant vehicles made of impractical materials.

The three "wrong material vehicles" mentioned in the comic are:

- The Spruce Goose - The largest flying boat ever made, in spite of its name, almost entirely out of birch wood. Most modern planes of that era were being constructed out of aluminum or some other metal/alloy. Due to wartime restrictions on aluminum usage, the use of birch wood was the next best option. The development of the aircraft was highly troubled due to various factors (including building in wood at an unprecedented scale), and the designers were accused of war-profiteering with an impossible design. The plane did make a single 26-second flight in 1947, well after the end of the war, but all it did was merely prove that the concept was possible. The plane is currently on display at the Evergreen Aviation & Space Museum in

McMinnville, Oregon, United States. Other wooden aircraft of that era, such as the De Havilland Mosquito, were highly successful. Many early planes made use of wood in their construction, and the skills and knowledge to build an airframe of that kind were still readily available in that era, in a way that they might not be today.

- Project Habakkuk - A proposed aircraft carrier whose hull was to be made out of pykrete (a mixture of wood pulp and ice). It would have been able to be easily camouflaged as an innocuous iceberg, and it was both stronger than steel (which the Mythbusters proved in a 2008 episode) and did not require voids between the structural elements in order to be buoyant (so could absorb a lot of damage and cannot spring leaks). Although the project excited great enthusiasm from Churchill, it quickly became clear that Pykrete did not scale well as a material, needing to be super-cooled to prevent creep, requiring a massive cooling system causing expense and engineering challenges to mount until it was concluded that it would be cheaper to build traditional steel-alloy hulls, from which ships continue to be built today, given that large quantities of metal were pulled in to prevent the ship from warping under its own mass via extra cooling and structural support. There were also now airfields available to use in various Atlantic islands that could close the air-gap in coverage without having to (effectively) build their own floating island from scratch. The abandoned prototype lasted for several years before it finally melted.

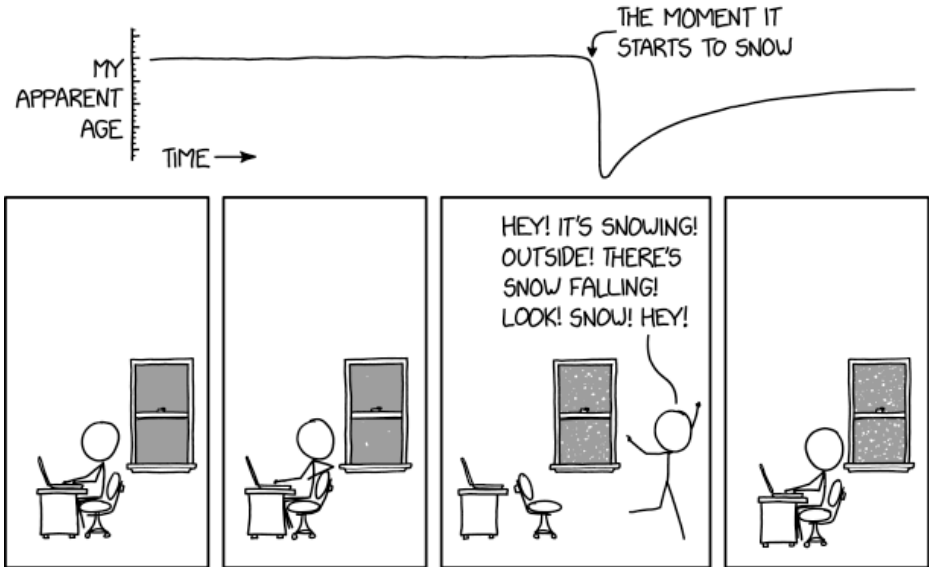
- Trojan Horse - A mythological, giant wooden horse, supposedly used by the Greeks to invade the city of Troy. Actual horses are composed, like any other animal, out of meat, bone, and other tissues and bodily fluids.[citation needed] In addition, the interior of the Trojan Horse was composed of Greek warriors rather than horse innards.

The title text references 19th-century author Edward Everett Hale and his science fiction novella *The Brick Moon*, the earliest known depiction of an artificial satellite and a scientifically-accurate GPS system in fiction. The satellite was made from brick as it is a refractory ceramic material capable of dealing with high heats. The novella is, of course, just a sci-fi story, but the title text states that Hale was actually approached by the Material Phantom, and the novella was a serious proposal for a moon made out of bricks. Ceramics are widely used in spacecraft today, largely as part of thermal protection systems, as they are lighter than most metals and able to withstand high temperatures.

The title, "The Wrong Stuff", may be a play on *The Right Stuff*, a book/movie/TV series about the pilots engaged in U.S. postwar research with experimental rocket-powered, high-speed aircraft and the astronauts of Project Mercury. In that title, "the right stuff" refers to the figurative material that these men were made of which gave them the bravery to embark on these missions.

#2866: Snow

December 11, 2023



For someone who has ostensibly outgrown staying up late waiting for Santa, I do spend an awful lot of time refreshing websites to see if packages are here yet.

Explanation

This comic is about people being excited by snow, which can induce what might be seen as "childish" or less mature behavior. Many people like snow for a variety of reasons; it may be nostalgic for them, in areas where it is infrequent it may be the novelty factor, it may be aesthetically pleasing, they may simply like walking around in snow, etc. The first snow of the 2023-2024 winter occurred in Boston (Randall's hometown) on December 6th, possibly inspiring this comic.

As the graph shows, Randall's "apparent age" drops significantly when snow starts to fall, and while it rises fairly quickly as the initial rush of excitement subsides, it is still lower whenever snow is falling (and possibly beyond this, while it is still lying). Evidently, the mere presence of snow keeps Randall acting somewhat childishly; it may take a lot more time (or reality-inducing grown-up events) to catch up to his true age. He can be seen staring out of the window in the fourth panel, obviously still significantly entranced and distracted, even if he is no longer running around in supposedly age-inappropriate excitement.

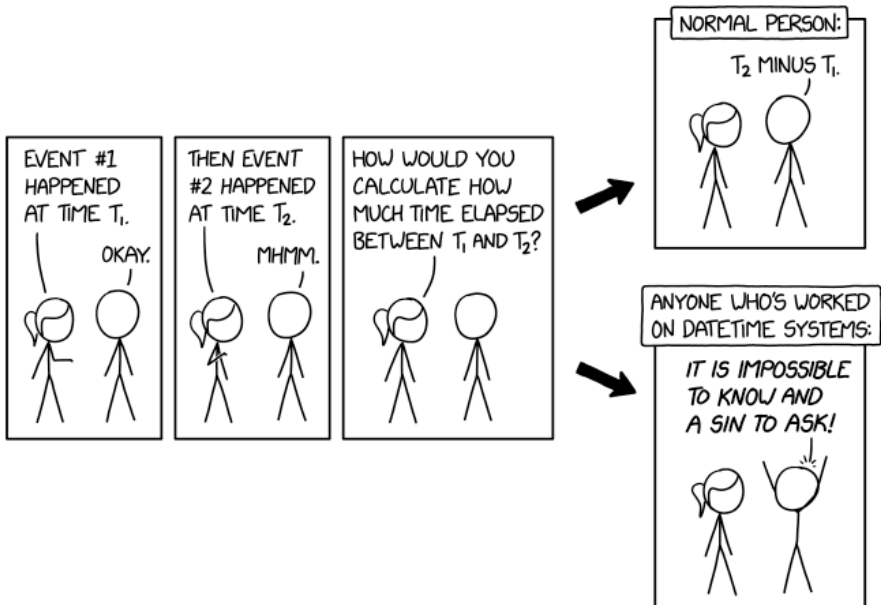
The title text refers to another common behavior of many adults - constantly refreshing tracking websites to see if a package has moved - and compares it to the idea of a child who believes in Santa and tries to stay up late enough to see him deliver presents. Constantly refreshing tracking websites is an unproductive behaviour and

should be discouraged in favour of other more socially acceptable habits such as constantly refreshing xkcd to check if a new strip is out.

See also 231: Cat Proximity for another event which changes a person's behavior.

#2867: DateTime

December 13, 2023



It's not just time zones and leap seconds. SI seconds on Earth are slower because of relativity, so there are time standards for space stuff (TCB, TGC) that use faster SI seconds than UTC/Unix time. $T_2 - T_1 =$ [God doesn't know and the Devil isn't telling.]

Explanation

Ponytail asks Cueball how to calculate the time elapsed between two instants. A Cueball not intimately familiar with the complexities of the way humans measure time naively assumes that this is given by the difference of the timestamps. A Cueball who is familiar panics and states that it is impossible to know, and further that it is forbidden to even ask the question.

Randall's use of the term "DateTime systems" covers any number of situations, and the complexities are hardly confined to any particular programming language, or indeed computers as a whole. Some of these complexities include time zones (and changes to time zones), the international date line, daylight saving time and differing observation (or non-observation) thereof in different areas (and changes to the observation of daylight saving time over time), leap days and leap seconds, etc. Another complexity is found in relativistic effects, in which the flow of time varies depending on how deep in a gravity well one is; Barycentric Coordinate Time and Geocentric Coordinate Time (in French, TCB and TCG respectively - the reference to TGC in the title text appears to be a typo) are time systems used for space missions and orbit calculations that handle this and shortly after this comic was published it was announced that Coordinated Lunar Time (LTC) would be established. A partial list of such minutiae may be found at Falsehoods Programmers Believe About Time. The title text of the comic also references some of them.

Depending on when T1 and T2 are, changes in calendar system may also be a relevant consideration—perhaps most famously, the change from the Julian calendar and the Gregorian calendar, two calendar systems which are nearly identical but nearly two weeks apart, and which different countries changed at different times.

The statement that "it is impossible to know" is because Ponytail did not provide enough information in the question: She needed to specify the location and time zone of both observations, and possibly the exact values of T1 and T2 to the nanosecond. Considering the restrictions imposed by relativity on two observers agreeing on the timing of events, it may be literally impossible to determine a value of $T2 - T1$ that is absolutely "correct" to arbitrary levels of precision.

The addition of "and a sin to ask" is hyperbolic. It implies that asking such questions is akin to attempting to acquire forbidden knowledge of the nature of God or the Universe, for example, through practices such as Numerology, which some may consider heretical. it's an expression of the fact that determining the answer accurately can be complicated, and programming systems that attempt to do this can be frustrating.

" $T2 - T1 = [\text{God doesn't know and the Devil isn't telling.}]$ ": This is a colloquial expression that riffs on the more common "God only knows" as well as "Hell knows and Heaven suspects", to suggest that the thing in question is even more unknowable than the usual type of unknowable thing, to the point where it may be an evil

invention of the Devil designed to cause complexity and frustration for the people having to deal with it.

#2868: Label the States

December 15, 2023



Even with a blank map, a lot of people can only name 45-50 of the 64 states.

Explanation

This is a blank map of the United States. At first glance, it looks correct, because all the large states with distinct shapes are correctly represented, but some states have been added. For example:

- On the west coast, Washington, Oregon, and California all have their normal shapes, but there is a new rectangular state south of Oregon and north of California.
- East of this, two more nearly rectangular states have been added between Idaho, Wyoming, Nevada, and Utah.
- A column of five rectangular states has been inserted between Montana/Wyoming/Utah/Arizona and the Dakotas/Nebraska/Colorado/New Mexico.
- Another somewhat rectangular state has been added between South Dakota and Nebraska.
- Ohio and Indiana have been narrowed with a new state being created between them.
- New states shaped like Arkansas, Tennessee, and North Carolina have been added directly south of those states.
- New Hampshire now has a state that looks like its reflection between itself and Maine.

In summary, a (disjointed) row and a whole (slightly staggered) column of states have been added, and two new states have been added between Indiana and Ohio

and between New Hampshire and Maine. The external shape of the United States ends up slightly modified to accommodate the new states with generic coastlines or borders contrived to resemble or reflect the actual adjacent ones, at least to the casual glance, as also with the new internal borderlines. As the title text says, there are now 64 states on Randall's map, not 50.

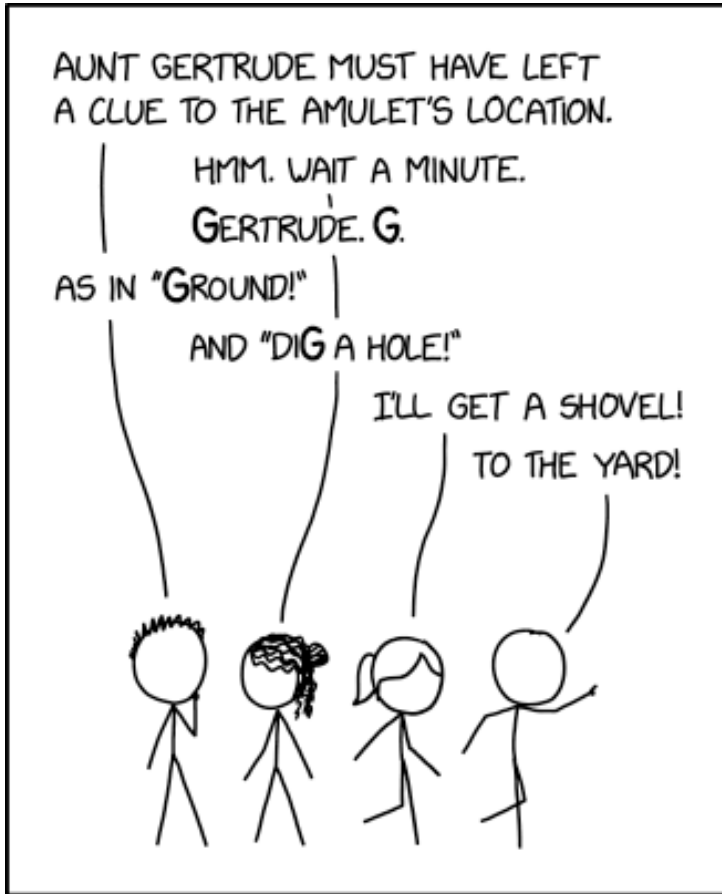
In comic 2394: Contiguous 41 States (with label), the opposite has been done, removing states so that there are 41 states instead of 50 or 64.

The title text comments on the cliché that Americans are bad at civics and geography, parodying comments that Americans cannot name many of the US states. A statistic is mentioned saying that most people can only name 45-50 states, which is almost all of the actual states, but looks poor in comparison to the 64 states in the comic's map. Since the extra fourteen states are made up and do not have names,[citation needed] people will not be able to name them and get a perfect 64/64 score. The cliché is also parodied in 850: World According to Americans.

Being mean to people by asking them to name states on bad maps was also mentioned in the title text of 1653: United States Map.

#2869: Puzzles

December 18, 2023



SOME OF THE AUTHORS OF BOOKS I READ AS
A KID WERE **TERRIBLE** AT DESIGNING PUZZLES.

Why couldn't the amulet have been hidden by Aunt Alice,
who understands modern key exchange algorithms?

Explanation

Many children's books, especially those read by Randall's generation, feature in-story puzzles. Some of these hold up pretty well decades later, like the ones in Ellen Raskin's award-winning mystery books for kids. Others, however, are...a lot less impressive. Randall doesn't specify which children's books have "terrible" puzzles, but the Hardy Boys series by Franklin W. Dixon, the Boxcar Children series by Gertrude Chandler Warner, and the Encyclopedia Brown series by Donald J. Sobol are all strong possibilities. (The Riddler in the 1960s Batman TV series famously played the trope for laughs.)

In the panel, characters from one such book (presumably a made-up example) are contemplating a puzzle involving somebody's Aunt Gertrude. The characters guess Gertrude's amulet must be hidden in the Ground, because that starts with a G, like Gertrude, and that they should diG a hole. These guesses are not very practical; it seems unlikely that Aunt Gertrude either (A) chose to be known indefinitely by a G-name purely as a clue about where she hid an amulet, or (B) was inspired by her own name to choose a vaguely relevant hiding place. Even if she did, there are many other words that begin with G, such as Gulf, or Gull, or Get-a-Glider-and-Go-to-Greenland, or Get-a-nuke-and-bomb-the-USA, and any of these would be just as plausible "clues."

Moreover, once deciding, even more implausibly, that

this "clue" is telling them to dig a hole in the ground, because 'dig' ends with a G, the search is not significantly narrowed as the world is a big place and "underground, somewhere" leaves a huge range of possible locations. As for the comic, perhaps it could be a Garden, which the characters don't figure out. If you're still lost, you may need at least one more letter to narrow the options down. All this leads us to Randall's point — that these connections made by the characters are tenuous at best and are unreasonable to make, especially as part of a riddle.

Aunt Gertrude is probably named after a supporting character in the Hardy Boys series; the Aunt Gertrude in that series didn't set puzzles, but main characters Frank and Joe Hardy frequently had to decipher clues to find hidden objects. The name may also be a nod to Gertrude Chandler Warner, whose *Boxcar Children* are an adventurous group of mystery-solving kids like those in the comic.

The title text references Alice, a fictional character commonly used in discussions about cryptography. In those discussions, Alice is often sending and receiving encrypted messages, and she would be expected to be able to make a better puzzle than the one shown in the comic. The title text may also be referring to AES, a common modern algorithm used for encryption that begins with A and advances the alliteratively assisted approach to advancing an acquirable answer (and, accordingly, automatically attested as absolutely 'accurate'). In context, finding a key to decrypt a phrase

with AES would be a reasonable puzzle. Alice and Bob and other characters from the same set are the reverse of case of Aunt Gertrude, in that they have been given their names to reflect a convenient A, B, C, ... pattern. They have been mentioned previously in xkcd, like in 177: Alice and Bob. Using modern cryptography in lieu of riddles in children's stories was also mentioned in 370: Redwall.

#2870: Love Songs

December 20, 2023



The Pia Colada song carves a trajectory across the chart over the course of the song.

Explanation

The comic shows an xy-chart of various love songs, graphed according to how the subjects of the song feel. The x-axis represents the narrator/singer's feelings for whomever they are singing to or about, from "No!!" to "Yes!!", while the y-axis represents the other person's feelings for the one singing the song.

The songs can be found in Spotify playlists (,,).

#2871: Definitely

December 22, 2023

<u>WORD</u>	<u>MEANING</u>
DEFINITELY	— DEFINITELY
DEFINETLY	— ALMOST DEFINITELY
DEFINATELY	— PROBABLY
DEFINATLY	— PROBABLY NOT
DEFENITELY	— NOT TELLING (IT'S A SURPRISE)
DEFINETELY	— PER THE PROPHECY
DEFINETELY	— DEFINITELY, MAYBE
DEFINANTLY	— TO BE DECIDED BY COIN TOSS
DEFANITELY	— IN ONE UNIVERSE OUT OF 14 MILLION
DEFINEATLY	— ONLY THE GODS KNOW
DEFINITLY	— UNLESS SOMEONE CUTE SHOWS UP
DEFIANTLY	— DEFIANTLY

PEOPLE THINK THE WORD "DEFINITELY" IS OFTEN MISPELLED, BUT IT'S ACTUALLY JUST SEVERAL WORDS WITH DIFFERENT MEANINGS.

A really mean prank you can play on someone who's picky about words is to add a 'definitely->definitively' autocorrect rule to their keyboard.

Explanation

The word "definitely" is known to be commonly misspelt, perhaps because the vowels in the middle syllables are reduced to unstressed centralized ones that which alternate vowel letters may serve, or given a toneless neutral vowel on the verge of being omitted completely. (Wiktionary gives three variations, /'dɛf.i.nɪt.li/, /'dɛf.ə.nɪt.li/, /'dɛf.nɪt.li/, which are just some of the differences you might encounter.) Remembering that it ultimately has a common root with "finite", and thus has the two 'i's, might not help if you also/instead perhaps link it in your head to "define" (which might erroneously lead to "definetely") and not "definition".

The comic gives twelve 'words' that the subtitle claims are all real, and gives their definitions, whereas in reality only the first (the definitely definitive spelling of "definitely") and the last (defying the trend by being the actual word "defiantly") are indeed so.

The first three alternate 'words' listed do have Wiktionary entries that indicate they are common mis-spellings of the first, and the last has a secondary 'meaning' of possibly being such an error, but (as of the publication of this comic/edit) the words "defenitely", "defintely", "definetely", "definantly", "defanitely", "defineatly" and "definitly" are so wrong that they don't even have a corrective article created for them. Some of them don't even look like they'd even be sufficiently

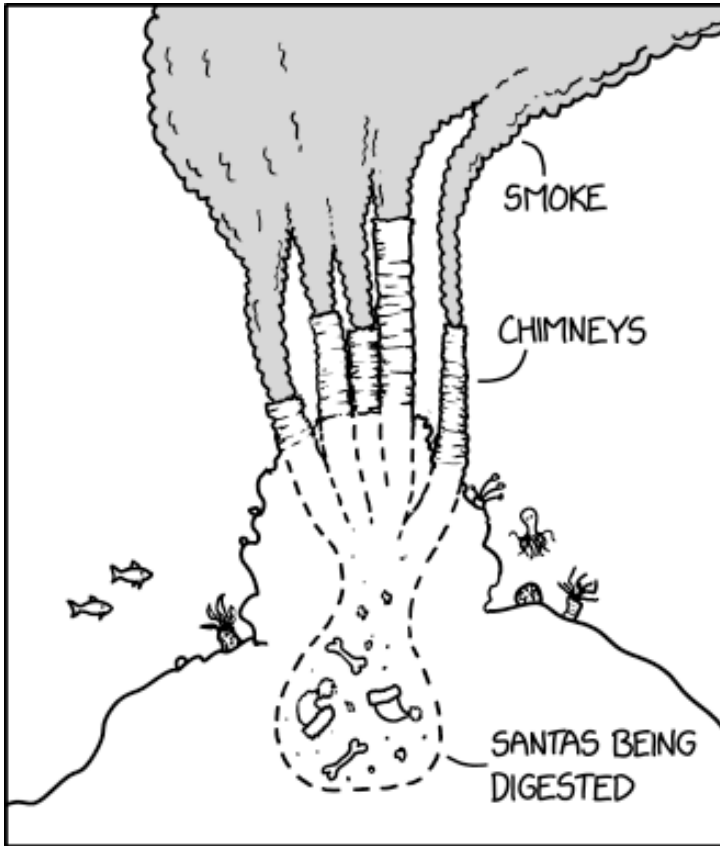
homophonic substitutes, though the actions of accent and dialect may indeed be capable of creating compatible (mis)elocutions for each.

The title text adds to the word confusion by suggesting the real word "definitively" (for which Wiktionary has a 'See also' link to "definitely") be made to be used (against the will of a word-wise individual) as a substitution for the original definitely definitive spelling. In certain contexts it even fulfils the same basic sense as the original and so may survive proofreading by a third party. Or even the author glancing through their own work, and the brain not twigging the increased number of riser-rich characters but mentally voicing the intended word anyway... Even if it is noticed, it may be considered more a "thinko" than a "typo" as it keeps happening, at least until the afflicted typist starts to pay close and distracting attention to their output.

This kind of substitution is a recurring subject on xkcd, with one of the more famous ones being 1031: s/keyboard/leopard/, where "keyboard" is replaced by "leopard" in the text.

#2872: Hydrothermal Vents

December 25, 2023



OCEAN FACT: HYDROTHERMAL VENT BLACK SMOKERS ACTUALLY EVOLVED AS PREDATORY CHIMNEY MIMICS TO FEED ON BENTHIC SANTAS.

Benthic Santas weren't even discovered until the 1970s, but many scientists now believe Christmas may have originally developed around hydrothermal vents and only later migrated to the surface.

Explanation

This Christmas comic was released on Christmas Day 2023, in the morning (at least in Randall's timezone in Boston). It is the second Christmas comic using Facts, an Ocean Fact in this comic. The first of these was released six years earlier, also on Christmas Day in comic 1933: Santa Facts. In the world above the surface of the sea, Santa Claus had just finished his annual trip around the world when this comic was posted.

The comic claims that there are "benthic Santas", meaning Santas that deliver gifts to the seafloor. The joke here is that all Santas may be drawn to go down chimneys by their very existence, and that hydrothermal vents have evolved to trick undersea Santa into entering them, believing they were real chimneys, and thus getting killed and digested by the vents as seen in the comic. This is not an entirely unknown digestive mechanism, although the depicted version goes beyond all known biological processes. This comic is one of the darker-themed Christmas comics, compared to the usual merry xmas comics.

There are many things that are very strange mentioned. There is little to no evidence that actual humans live down deep in the sea, and fish and other undersea creatures are unlikely to know what "Santa" is or understand the concept of Christmas, so it is unclear what the exact ecological niche of "benthic Santas" might be. The comic shows the remains of several "Santas",

suggesting that there may be multiple members of this 'Santa' species, in contrast to some assertions in the literature that there is only one (although this proliferation might also help explain the many Santas who appear on street corners, shopping malls, etc.). It is also possible that there is just one extant specimen Santa at any time (perhaps or perhaps not of the specifically subsea variety), whose death invokes the spontaneous appearance of a replacement, or causes (clauses?) another transformation into the 'santa' form, through socially-mediated dimorphism, from a population of initially non-santaform individuals.

The title text may be referring to abiogenesis, the origin of life. It was thought non-living matter combined into living cells in shallow water through the energy supplied from the sun and lightning. At least, amino acids can be synthesized this way, as proven by the Miller–Urey experiment. A new explanation places the origin of life on hydrothermal vents, as they are rich in chemicals, and rocks there serve as catalysts, with energy coming from earth's heat. Either way, forms of life are known to migrate between environments to fill new (or vacated) niches, after having been established in another. The current residents of 'black smokers' include creatures (like shrimps, worms and crabs) that are known elsewhere, but could theoretically repopulate the surface if there were ever further mass extinctions across the uppermost layers of the real world, as there have been in prior times.

The 1970s timeframe likely refers to the discovery in

1977 of hydrothermal vent ecosystems near the Galapagos Rift, which formed the basis of this new theory of abiogenesis. By suggesting that the "benthic Santas" were part of this discovery, the comic implies that a key aspect of Christmas folklore might also have its roots in these deep-sea ecosystems.

This was the second time in three years that Santa is killed in Randall's Christmas comics, the first being 2559: December 25th Launch. Before this he has only killed Santa back in 2008 in the 2008 Christmas Special.

#2873: Supersymmetry

December 27, 2023



THE THEORY OF SUPERSYMMETRIC MARIO
BROS SUGGESTS THAT EACH FUNDAMENTAL
PARTICLE HAS A SUPER NINTENDO PARTNER.

High-speed collisions at the Baby Park track may support the hypothesis that Daisy is her own evil twin, a theory first suggested by Nintendo in the game Majorana's Mask.

Explanation

This comic imagines a "theory of supersymmetric Mario Bros." that merges the theoretical physics concept of supersymmetry (explained below) with another "super" thing, Super Mario Bros., originally developed for the Nintendo Entertainment System and later the Super Nintendo Entertainment System (SNES), two home game consoles popular during Randall's childhood. Mario game characters are equated with certain subatomic particles, with the central protagonists Mario and Luigi (his brother) comprising the center of an atom (proton and neutron).

The "Free Luigi Decay" diagram is a Feynman diagram, a particle physics depiction of interactions between particles. This diagram reinterprets the process of free neutron decay, in which a neutron that is left alone — not part of a nucleus with a proton — is unstable, such that one of its constituent quarks will transform, making a more stable proton, by emitting a W- boson (not shown, or renamed), after around 10 to 30 minutes. The boson will then almost immediately decay into a suitable electron and neutrino. In Free Luigi Decay, the Luigi particle decay leads into there being a Mario, a Peach, and a notably right-handed Daisy, which would imply that this particular Daisy represents a sterile neutrino. The instability of a Luigi particle could be a reference to the fact that Luigi is almost never seen without Mario; decades of Mario games and spinoffs have produced just a few Luigi-only video games, such as Mario Is Missing!

and the Luigi's Mansion series.

The Mario characters and their subatomic particle equivalents:

* - to within experimental uncertainty

The Mario-Peach particle relationship is appropriate. Just as Mario is attracted to Princess Peach in the first generation of Mario games, so is the Mario particle (proton) attracted to the Peach particle (electron).

The particle assignments for Peach and Daisy are also appropriate. Just as Princess Peach is often the central character (e.g., needing rescue) with Princess Daisy usually playing a supporting or secondary role, so too is the electron a well-known particle with a significant role in forming atoms and determining chemical properties, while the neutrino is more elusive, playing a less obvious role in the universe.

The title text is a pun on the title of the Nintendo 64 game *The Legend of Zelda: Majora's Mask* and the concept of Majorana fermion, which attempts to reconcile how, while many particles have separate antiparticle counterparts, certain ones do not. Until this is resolved, scientists may depict a theoretical antiparticle in place of a neutrino in order to preserve various total values across the diagram. But scientists do wonder if a neutrino is its own antiparticle, much as they have also previously wondered if they also flip their 'flavor' as a way to explain certain experimental results.

Baby Park is an oval-shaped race track in the Mario Kart series and used as a particle collider in the title text, first featured in Mario Kart: Double Dash!! on the Nintendo GameCube, and most recently appearing in Mario Kart 8 Deluxe for the Nintendo Switch. The Baby Park track is unusually short by the series' standards, making collisions between racers more likely than on the other, longer tracks.

This comic was posted shortly after the release of concept art from Mario Tennis (the game where Waluigi debuted) of Wapeach, an "evil" counterpart to Peach which was ultimately scrapped. Under the model depicted in the comic, Wapeach would serve as a positron analogue.

Background on subatomic particles[edit]

At the atomic level, particle interactions may involve the bulky nucleons (protons and neutrons, these being each a particular triumvirate of quark 'flavors'), electrons (smaller, charged fermions) and various others (such as neutrinos, also fermions, chargeless and often nearly massless). Sometimes other more exotic/fundamental particles (force-mediating or otherwise transient) are included.

Added within the standard model are the "antiparticles" that are oppositely charged (or built up of more fundamental antiparticles), and further issues have required extending this further through theories of supersymmetry which further adds counterparts that have alternate 'spin's.

The right-handed Daisy (Electron Neutrino) means that Daisy's

direction of spin (in subatomic terms, a measurement which does not now match that of the angular momentum in classical physics which inspired its naming) is the same as the direction of motion. A left-handed Daisy (Electron Neutrino) would have the opposite value.

Certain current understandings of the process require that the electron neutrino be an antineutrino, but antineutrinos have not so far been sufficiently confirmed to exist, with some theorising that a neutrino can be its own anti-particle (unlike the neutral neutron, composed of charged quarks, which has the similarly neutral antineutron, composed of oppositely charged antiquarks).

#2874: Iceland

December 29, 2023



ICELAND WAS DESIGNED BY A COMMITTEE OF PLANETARY SCIENTISTS THAT WAS TRYING TO SATISFY EVERYONE.

The HVAC bill for installing the Gulf Stream was enormous.

Explanation

This comic is a reference to the strange geography of Iceland, owing to the sheer number of notable geographical features in such a small area, leading to the conclusion by Randall that Iceland had to have been created by a committee of various planetary scientists all vying to have their ideas implemented into their 'project', that being Iceland.

In the comic, Cueball is giving a presentation to members of the committee, consisting of White Hat, Blondie, another Cueball, Megan and Hairbun, sitting around a table. It may have been inspired by Iceland being recently in the news for its notable volcanic activity.

Noting that being nearer the magnetic pole might more frequently provide you with an aurora, but the more severe (on the Kp index) geomagnetic storms invoke their auroral displays at lower latitudes. Once you get a Kp of 5 (out of a theoretical 9), Iceland may be far too close to the pole to fully appreciate the sight.

HVAC in the title text is jargon for heating, ventilation, and air conditioning. The Gulf Stream is a warm and swift Atlantic ocean current that originates in the Gulf of Mexico and flows through the Straits of Florida and up the eastern coastline of the United States, then veers east near 36 degrees latitude and moves toward Northwest Europe as the North Atlantic Current, providing Iceland

with a milder and more liveable climate than would be otherwise expected for its latitude. The electrical costs associated with providing airflow at a certain temperature, over such a vast area would prove incredibly expensive, not to mention the fact that the Gulf Stream is not in fact an artificial phenomenon powered by electricity, but rather a natural one.[citation needed]

Legal Information

XKCD Comics

This PDF is a derivative work of XKCD comics by Randall Munroe. All XKCD comics are Copyright © Randall Munroe and are licensed under the Creative Commons Attribution-NonCommercial 2.5 License (CC BY-NC 2.5).

This license allows for non-commercial distribution of the comics, meaning you may share and distribute this PDF as long as you do not charge money for it or use it for any commercial purpose. You must give appropriate credit to Randall Munroe and xkcd.com, and provide a link to the license.

For the full license text and terms, visit: <https://xkcd.com/license.html>

Original comics available at: <https://xkcd.com>

Explain XKCD

Comic explanations are sourced from Explain XKCD (explainxkcd.com). Explain XKCD is licensed under the Creative Commons Attribution-NonCommercial 2.5 License (CC BY-NC 2.5). This means you may share and distribute these explanations as long as you do not charge money for them or use them for any commercial purpose. You must give appropriate credit to explainxkcd.com and provide a link to the license.

For the full license text and terms, visit: <https://creativecommons.org/licenses/by-nc/2.5/>

XKCD Font

The XKCD font used in comic captions is licensed under the Creative Commons Attribution-NonCommercial 3.0 License (CC BY-NC 3.0). This means you may share and distribute the font as long as you do not charge money for it or use it for any commercial purpose. You must give appropriate credit and provide a link to the license.

For the full license text and terms, visit: <https://creativecommons.org/licenses/by-nc/3.0/>

EB Garamond Font

The EB Garamond font used in the main text is licensed under the SIL Open Font License (OFL) Version 1.1. This license allows for free use, modification, and distribution of the font, as long as it is not sold by itself. The font must remain under this license.

For the full license text and terms, visit: <https://openfontlicense.org>

Disclaimer

This PDF is created for non-commercial distribution only. The content is not officially endorsed by or affiliated with xkcd.com or explainxkcd.com. All rights remain with their respective owners.